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Abstract

Title of Dissertation: Effects of Environmental Stress on Individual Decision-Making

Monica H. Schaeffer, Doctor of Philosophy, 1987

Dissertation directed by: Jerome E. Singer, Ph.D., Department of Medical Psychology

While many of today's judgments and decisions are frequently made under conditions of duress, empirical evidence is lacking for the effects that environmental stressors have on decision-making. The present research examined the effects of an acute, unpredictable, and uncontrollable stressor on the use of heuristics, or shortcutting strategies for making decisions.

In order to determine the use of heuristics in a sample comparable to the study sample, a decision-making instrument covering four different heuristics was administered to 100 undergraduates. The present results replicate previous research that has shown that the majority of respondents employ a heuristic in making decisions. However, low reliability coefficients between and among the heuristics suggest that heuristic use is not traitlike, i.e., individuals are not consistent in their use of heuristics, using them at some times, but not others.

The second part of the research consisted of two experiments conducted in parallel fashion. The first experiment was designed to examine the effects of an environmental stressor on decisions made during exposure to that stressor. Stress did not affect the decision-making process. Subjects used a comparable number of heuristics regardless of whether they were exposed to a stressor or not. While stress did not affect cognitive performance, there was a tendency for it to increase a

person's confidence in his/her decisions. In addition, exposure to the stressor resulted in significant behavioral aftereffects. Specifically, males who had been exposed to the stressor showed significantly less tolerance for frustration than males in a control group. Females persisted regardless of whether they were exposed to the stressor or not.

The second experiment was designed to examine the effects of an environmental stressor on decisions made after the stressor was terminated. Results of the second experiment showed that aftereffects of stress included both increases in the use of shortcutting strategies (heuristics) and increased confidence in the decisions that were made. The adaptive cost hypothesis and the cognitive overload hypothesis can be used to explain the mechanisms by which stress exerts these aftereffects. Future research questions raised by the present research as well as practical implications of these results are discussed.

EFFECTS OF ENVIRONMENTAL STRESS ON INDIVIDUAL DECISION-MAKING

by

Monica H. Schaeffer

Dissertation submitted to the Faculty of the
Department of Medical Psychology Graduate Program of
the Uniformed Services University of the Health Sciences
in partial fulfillment of the requirements for the degree of
Doctor of Philosophy 1987

Dedication

To my parents who instilled in me a thirst for knowledge, a desire for excellence, and the determination to achieve the ultimate.

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I wish to thank members of my committee, W. Emmett Barkley, Andrew Baum, David Krantz, James Peters and Jerome Singer who helped to breathe life into this major personal endeavor. Thanks also to Agnes Richardson, who not only transcribed my scribbles and figured out where my inserts went, but who worked with me in only the best of spirits to produce the finished document. Thanks to my daughter, Erica, who literally began life when I began USUHS, and who served as a wonderful distracter. And finally, thanks to my husband, Mitchell, my personal beacon of light always shining bright, right through to the end of the tunnel.

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Chapter 1

Introduction

Statement of the Problem

The advances that have been made in modern technology have radically changed the hierarchy of needed human skills (Slovic, 1982). Human strength and motor performance have become less important for many jobs. Intellectual capabilities, especially judgment and decision making skills, have become the crucial human elements. Further, today's judgments and decisions are frequently made under conditions of duress. Modern society is characterized by stress-inducing conditions such as time pressures, job insecurity, and work overload under which individuals are expected to function. Such conditions may influence the decisions that are made.

While difficulties in decision-making have been recognized, these difficulties have often been blamed on the inadequacy of available information. Yet, despite the ability to amass considerable amounts of data with the aid of computer technologies, the human being is still left with doubts and uncertainties with which to reckon.

The effect that environmental stressors have on decisions remains a largely unexplored area. However, the coexistence of these two conditions, namely the need to make decisions and the presence of stressful conditions, is a common occurrence in all walks of life. A dramatic example of this situation is provided by the following scenario: A patient is admitted to a hospital intensive care unit with a severely damaged central nervous system. There is mobilization of sophisticated medical technology, intensive diagnostic and life-saving activities, and a need for highly significant decision-making by the entire ICU staff

(Lippincott, 1979). The task of restoring bodily functions and saving the patient's life, in and of themselves stressful, must be performed within an environment characterized by noise, enforced intimacy, thoughts of death, heightened decision-making responsibility, and concerns about anxious or disturbed family members. How do these multiple stressors affect the cognitive abilities of the ICU team? Are life/death treatment decisions affected by the stressors? Are there any chronic effects of making decisions under stress when the stressors are no longer present?

Research integrating the areas of stress and decision making is needed to answer these questions. This study describes research that will begin to address these issues, attempting to integrate findings from work on stress and on decision making.

Defining Stress

One of the problems plaguing research that examines the effects of stress is the many ways in which stress has been defined. The major models of stress proposed by Selye (1956, 1976) and Cannon (1928) characterize stress as a natural bodily defense against physical threat, primarily. The research of these two individuals highlighted the integral roles that the hypothalamic-pituitary-adrenal cortex axis (PAC) and the sympathetic-adrenal medullary (SAM) system play in the physiological stress response. In these models, responses to psychological and physiological stressors were not discriminated. Mason (1975), however, suggested that psychological threats were necessary for adrenal activity (i.e., epinephrine) in the stress response, contrary to Selye's position that pathogens were sufficient for pituitary-adrenal activation.

The psychological stress model advanced by Lazarus (1966) views psychological variables as instrumental in the onset of stress. Specifically, this model emphasizes the role of interpretation or appraisal of stressors in the stress response. Response to stressors is determined by the degree to which an event is perceived as threatening, harmful or challenging (Lazarus, 1966). A stress response is likely to follow if the demands of the event or situation placed on the individual are perceived as exceeding his/her abilities. The appraisal of each stressor depends on a number of factors including prior experience with the stressor, perceived control, attitudes toward the stressor, and knowledge of its consequences. If a situation is judged as stressful, Lazarus theorizes that secondary appraisals are made. Specifically, the perception of harm or threat motivates the person to search for coping responses that will reduce the harm or threat.

These coping strategies may take the form of "direct action," where the responses are directed towards the environment. The individual seeks to change his or her relationship to the stressful situation by, for example, changing the setting, fleeing, or removing the stressor. When this is not possible, "palliative" coping may be directed towards the self and used to change the individual's "internal environment." For example, the individual may take drugs, use alcohol, or learn to relax, all responses designed to make the individual feel better or experience less discomfort.

While the physiological and psychological descriptions of stress advanced by Selye and Lazarus have led to different research agendas, both models emphasize an underlying process whereby an individual copes with and adapts to a threat. The overall process of perceiving a threat,

coping with it and adapting to it has been accepted as the definition of stress by researchers who measure stress using psychological, behavioral and physiological parameters. Baum, Singer and Baum (1981) have defined stress as a "process in which environmental events or forces called stressors, threaten an organism's existence and well-being and the organism responds to this threat." This study seeks to extend the understanding of this process by focusing on the cognitive strategies that are involved in making decisions in the presence as well after termination of an environmental stressor.

Stress and Decision Making

While a theory linking stress and decision making has been developed by Janis and Mann (1977), the emphasis has been placed on the stress arising from or associated with the decision making process, itself. Their theory attempts to specify the contrasting conditions that determine whether the stress brought on by the decisional conflict will either facilitate or interfere with effective searching for and appraisal of alternative causes of action. The focus of this decisional conflict theory has been on emergency-type decisions rather than those encountered in everyday life.

Literature addressing the effects of environmental stress on decision making is limited. Cleland (1965, 1967) examined nurses' achievement level and social interaction skills under four graduated levels of stress. The stressor conditions were defined by combining several factors in the work environment believed to exert significant stress on nurses. The factors affecting the quantity of stressors were 1) the physical dependency of the patient ranging from 3, most dependent (e.g. confined to bed and had to be fed) to 1 (ambulatory and needed no

help with daily living activities; 2) the number and type of nursing staff available; 3) the work assignment of the nurse being tested; and 4) the time and place in which the nurse took the tests. Sixty staff nurses on medical and surgical units, ranging in age from 20-23 years old, were randomly assigned to one of the four stress conditions. A combined performance score showed that nurses under moderately low level of stressors (Condition II) performed best. The author suggested that those nurses performing under the lowest level of stressors (Condition I), lacked sufficient stimulation for maximum performance. Nurses in the other two conditions also did worse than those in Condition II. The authors suggested that since these two conditions were comparable to Condition II in terms of patient dependency and staffing, the increased responsibility associated with leadership, manifested either by being a team leader in Condition III or the nurse in charge in Condition IV, added to the perception of environmental stressors. Two other findings were noted. For difficult test items, quality of performance deteriorated more rapidly than for less difficult items in Conditions III and IV and performance on social interaction questions deteriorated more rapidly than performance on general factual items in both of these conditions as well. It is difficult to evaluate the meaningfulness of the conclusions since no data, other than mean performance scores of the different groups, are provided.

An inverted U relationship between stress and individual problem solving has also been used by Renner and Renner (1972) to explain results from a study in which 40 undergraduate male students were asked to solve a moderately difficult concept-formation problem while working under one of four stress-inducing conditions. The stressor was manipulated by

varying the probability of the subject receiving one or more shocks during the experiment. No shocks were actually administered. The authors reported that performance of individuals under the very high and very low stress conditions performed significantly poorer than under the intermediate stress levels. However, no measures of either physiological or subjective feelings of arousal were obtained.

Three studies have looked at changes in the decision making process itself rather than performance proficiency. Strelau and Maciejczyk (1977) studied civilian male pilots between the ages of 20-40 years old and manipulated stress by varying the task characteristics. Under the nonstress conditions, pilots were informed that they had to perform several simulated flight assignments in which they had to verbally communicate their decisions and enumerate successive operations that had to be undertaken in the flight situation. Under the stressful condition, the same instructions were given with the addition that the decision had to be made in the shortest time possible and that their speed and quality of decision would be evaluated and considered when deciding on their future career. The time elapsing from the moment of transmitting the information to the moment in which the pilot began to issue a correct response was used as the indicator of speed of decision making. The quality of each decision was rated on a 3 point scale by three instructor pilots. The three judges ratings correlated from .43-.72 indicating this measure was only moderately reliable. The authors did not analyze the data for main effects of stress. Rather, they divided subjects into whether they were high or low reactive "types" in terms of an alpha index, an indicator expressing in percent form, the number of alpha waves present in an EEG recording at rest. However,

from the data reported, subjects under the stress conditions made quicker decisions but, the quality of their decisions were rated as poorer than those under the no-stress conditions. The significance of these findings cannot be assessed from the data provided.

A second study examined the effects of time pressure as well as distraction on the decision making process (Wright, 1974). Two hundred and ten soon-to-graduate male undergraduates enrolled in a business curriculum were presented with five pieces of information for each of 30 cars to assimilate and decide which car they would consider purchasing for personal use after graduation from college. The subjects were randomly assigned to one of three time pressure conditions or one of three distraction conditions. Time pressure was manipulated by imposing an implied or real time limit in the high and medium conditions, respectively, and in the high condition, recording the elapsed time in 10 second intervals on a blackboard. Level of distraction was manipulated by playing throughout the session, a taped excerpt from a radio talk show at a moderately high or low volume respectively, for the high and medium distraction conditions. In the low distraction condition, taped background music from an FM station was played. Subjects in the high time pressure and moderate distraction conditions placed greater weight on negative evidence and attended to fewer data dimensions than those in the other conditions. The authors suggested that the high distraction manipulation may have disrupted the subjects' processing to a point where they became erratic. Subjects in the low time pressure and low distraction conditions showed no patterning of response. The authors conclude that their results provide evidence that limiting the nature and amount of data used is a preferred strategy for handling high

information load. Specifically, "the harassed decision maker is pictured as becoming extremely alert to discrediting evidence on a few salient dimensions (1974, p. 560)."

A third study examined the effects of stress on one aspect of the decision-making process, specifically dealing with the scanning and consideration of relevant alternatives. Keinan (1987) randomly assigned 101 undergraduates (42 men, 59 women) with a mean age of 25 to one of three conditions. In an uncontrollable stress condition, subjects were told that harmless but painful electric shocks might be administered in a random fashion while the subject worked on the task. In the controllable stress condition, subjects were told that their receiving shocks would be contingent on their performance, i.e. high quality performance could prevent the shocks. No shocks were actually administered in either of the groups. A non-stressed control group served as the third condition. A computerized multiple-choice analogies test, consisting of 15 items, comprised the task. Subjects received scores on three measures of faulty alternative scanning namely premature closure (i.e. number of times a decision was reached without scanning all the alternatives) nonsystematic scanning (i.e. deviations from forward or backward scanning) and temporal narrowing (i.e. average display time for each alternative scanned). Compared to the control group, subjects in both the controllable and uncontrollable stress condition had a greater incidence of premature closure and nonsystematic scanning. Stress had no effect on temporal narrowing. The author suggested that failure to find an effect might have been due to a floor effect since the time needed to scan the alternatives was minimal. Premature closure and nonsystematic scanning significantly correlated with poorer quality of performance.

The author also suggested that failure to find a difference between the controllable and controllable stress group might have been due to the lack of confidence in the ability of subjects in the controllable stress condition, to master the task and, therefore, be able to control the stressor.

The studies cited above suggest that the use of simplifying or short-cutting strategies in making decisions may be a means of how individuals adapt to stressful environments. In terms of Lazarus' model of secondary appraisal, an individual faced with a decision task of challenging complexity might try to restructure that task into a simpler one by using a variety of strategies. An individual might try to defer an impending decision deadline, physically remove the source of the distraction or remove himself/herself from the environment to a more peaceful location. Such strategies could be classified as means for maintaining or gaining control. Cleland (1967), in fact, reports that it is common to see staff nurses "hunting for a quiet place and time to teach a patient, or retreating to the linen closet or an examining room to plan her team's assignment (1967, p. 110)." When the individual's ability to alter the environment itself is limited, that individual may still try to restructure the task by, for example, restricting his/her attention to certain portions of the incoming data. Certainly the results of Keinan (1987) suggest that the detrimental effects of stress on decision making are mediated, at least in part, by premature closure and nonsystematic scanning of alternatives.

The use of simplifying strategies in making decisions has been a popular, recent theme also within the decision-making literature. A review of this research is provided in the following section.

The Role of Heuristics in Decision Making

Decision making is being studied within a variety of disciplines including medicine, economics, education, political science, engineering, geography, marketing, management science and psychology. Research in behavioral decision making has shifted dramatically in recent years. Up until the early 1970's work was characterized by a normative approach, i.e., developing formal models that would prescribe optimal decisions under uncertainty, given certain characteristics regarding the state of the world and the individual's value system. However, normative models and principles have been found to be inconsistent with human decision behavior (Wallsten, 1983). Present research is guided by empirical evidence that has specified a variety of heuristics used to explain how decisions are actually made.

Of most interest to this study is the research generated by the latter, descriptive, approach. In general, when faced with problems of judging probabilities, making predictions, and, more generally, coping with uncertainty, the individual uses judgmental heuristics defined as general strategies for simplifying complex tasks. Central to this cognitive processing approach is the concept of bounded rationality introduced by Simon (1957).

Simon was a critic of a particular normative model, utility maximization. He observed that:

> The classical theory is a theory of a man choosing among fixed and known alternatives, to each of which is attached known consequences. But when perception and cognition intervene between the decision-maker and his objective environment, this model no longer proves adequate. We need a description of the choice process that recognizes that alternatives are not given but must be sought; and a description that takes into account the arduous task of determining what consequences will follow on each alternative. (Simon, 1957; p. 272)

In his theory of bounded rationality, Simon asserts that it is the cognitive limitations of the decision maker which force him/her to construct a simplified model of the world to deal with it. The key principle is the notion of "satisficing" whereby the decision maker strives to attain a satisfactory rather than optimal or maximal level of achievement. Simon believed this process to be adaptive in dealing with a complex world. However, ". . . this adaptiveness falls far short of the ideal of "maximizing," postulated in economic theory. Evidently, organisms adapt well enough to "satisfice," they do not, in general, "optimize" (Simon, 1957, p. 129).

Tversky and Kahneman (1971, 1972, 1973, 1974, 1982) have devoted a great deal of experimental effort to understanding how people perceive, process and evaluate the probabilities of uncertain events. From this research has emerged two main judgmental heuristics or strategies that determine probabalistic judgments in a variety of tasks. These are availability and representativeness.

While these heuristics are characterized as "judgmental strategies," they differ from computational or judgmental algorithms in that their use is generally "automatic" and free of any conscious consideration of appropriateness. As Nisbett and Ross (1980) point out, these heuristics are not irrational or even nonrational. They are considered adaptive strategies for producing usually more correct than incorrect inferences. They may be an inevitable feature of the human's "cognitive apparatus" to aid in continuously making judgments, inferences and decisions. It is the misapplication or the overuse of these heuristics that will be emphasized in the following review.

Availability Heuristic

When the availability heuristic is employed, the probability of an event (e.g. snow in November) is judged by the ease with which relevant instances are imagined or by the number of such instances that are easily retrieved from memory. Since, in general, instances of frequent and likely events are typically easier to recall then instances of either less frequent or unlikely events, availability is often a valid one for assessing frequency and probability. However, Tversky and Kahneman (1973) point out that availability can also be affected by recency, emotional saliency and other subtle factors which are uncorrelated with actual frequency. If the availability heuristic is applied, then such factors will affect the perceived frequency of classes and the subjective probability of events. For example, the subjective probability of traffic accidents is likely to be rated higher, immediately after seeing a car overturned by the side of the road. With regard to salience, the subjective probability of fires is probably impacted more by seeing a house burning in one's neighborhood than by reading about a fire in the newspaper. As a result of these factors, use of the availability heuristic results in predictable systematic biases in judgment.

Demonstrations of the misuse of this heuristic are plentiful. Reliance on the availability heuristic can lead to inaccurate judgments of frequency due to what Tversky and Kahneman (1973) refer to as "ineffectiveness of a search set." For example, individuals have been asked whether five different consonants are more likely to appear in the first or third position of a word (Tversky and Kahneman, 1973). Despite the fact that all consonants are more frequent in the third position, the majority of subjects judge the letters to be more frequent in the first

than third position. In addition, the introduction of payoffs for accuracy have no effect, suggesting that lack of motivation is not an explanation for this result. Tversky and Kahneman (1973) explain this result by noting that people answer such a question by comparing the availability of the two categories, namely assessing the ease with which instances of the two categories come to mind. The judgment of frequency is influenced by the fact that it is easier to think of words that begin with a consonant than of words where it appears in the third position. Therefore, subjects judge that words beginning with the consonant are in fact more frequent than those in which the consonant is in the third position.

Reliance on availability also leads to biases due to the "retrievability of instances." An illustration of this bias is provided by a study in which people were asked to judge the frequency of 41 causes of death (Lichtenstein, Slovic, Fischhoff, Layman & Combs, 1978). In one study they were told initially that the annual death toll in the U.S. for one of the causes, motor vehicle accidents, was 50,000. They were then asked to estimate the frequency of the other 40 causes. Subjects' judgments were then compared with the number reported in public health statistics. The results showed that rare causes (e.g. fires, homicides) were overestimated and common causes underestimated (e.g. diabetes, stroke, emphysema). The rare causes that were overestimated, tended to be dramatic and sensational and more frequently reported in the mass media (Combs & Slovic, 1979). The underestimated causes tended to be unspectacular, to claim one victim at a time, and were more common in nonfatal form.

Fischhoff, Slovic, & Lichtenstein (1978) have noted that failure to appreciate the limits of available data lull people into a state of complacency. In one study, subjects were asked to evaluate the completeness of a fault tree showing problems that could cause a car not to start when the ignition key was turned on. Judgments of completeness by laypersons, as well as by experienced mechanics, were about the same whether or not three or six causes of starting failures, respectively, were provided. Decision makers appear to use only the information that is explicitly a part of the formulation of the problem.

Representativeness Heuristic

The representativeness heuristic (Kahneman & Tversky, 1972, 1973; Tversky & Kahneman, 1974) involves the application of relatively simple resemblance or "goodness of fit" criteria to problems of categorization (Nisbett & Ross, 1980). Many of the probabalistic questions with which people are concerned are answered by employing the representative heuristic. These questions belong to one of the following types: What is the probability that object A belongs to Class B and, What is the probability that Process B will generate event A. People typically answer these questions by the degree to which A resembles or is similar to B. For example, when A is highly representative or similar to B, the probability that A belongs to or originates from B is judged to be high. If A is not seen as being similar to B, the probability that A belongs to B will be low. Specific examples of each of these cases are provided below.

Errors arise in this approach to the judgment of probability because similarity or representativeness is not influenced by many

factors that should affect such judgments. The following review of studies is not meant to be exhaustive, but rather illustrative of the empirical findings that have documented the use of this heuristic and the factors that have gone unheeded.

The question of probability of belonging was tested in an experiment where subjects read brief personality descriptions of several individuals, allegedly sampled at random from a group of 100 professional engineers or lawyers (Kahneman & Tversky, 1973). Subjects were asked to assess, for each description, the probability that it belonged to an engineer rather than a lawyer. Despite the fact that subjects in two different conditions were told that the group of 100 consisted of either 30 engineers and 70 lawyers or 70 engineers and 30 lawyers respectively, subjects in the two conditions produced essentially the same probability judgements. The authors suggested that subjects were seduced by the representative heuristic. In other words, they assessed the relative "goodness of fit" between the personality profile and the predominant features of their stereotype of engineers and lawyers, with little or no regard for relevant category base-rate information. Prior probabilities were also ignored when the following description was provided that conveyed no relevant information to the question of whether Dick was an engineer or lawyer.

> Dick is a 30 year old man. He is married with no children. A man of high ability and high motivation, he promises to be quite successful in his field. He is well liked by his colleagues (Tversky & Kahneman, 1974).

Subjects judged the probability of Dick being an engineer to be .5 regardless of the manipulated probabilities. Only when no specific evidence was given, did subjects properly utilize the provided base rate information regarding the numbers of engineers within the group of 100.

The second question posed yields judgments that are likely to reflect the degree to which the specified outcome represents its origin. For example, in considering tosses of a coin for heads or tails, subjects regarded the sequence H-T-H-T-T-H to be more likely than either H-H-H-T-T-T which does not appear random or H-H-H-H-T-H which does not represent the fairness of the coin (Kahneman & Tversky, 1972). Only the first sequence was seen to be "representative" of the chance process. Misconceptions of chance have also accounted for the gambler's fallacy of thinking that after observing a long run of "red" on the roulette wheel, "black" is now due. As in the case of the coin toss, people erroneously believe that the occurrence of black will result in a more representative sequence than an additional red.

The use of the representative heuristic has also been applied to cases in which individuals are asked to evaluate the probability of obtaining a particular result in a sample from a specified population. The following question was used to demonstrate this.

> A certain town is served by two hospitals. In the larger hospital about 45 babies are born each day, and in the smaller hospital about 15 babies are born each day. As you know, about 50 percent of all babies are boys. The exact percentage of baby boys, however, varies from day to day. Sometimes it may be higher than 50 percent, sometimes lower.
>
> For a period of one year, each hospital recorded the days on which more than 60 percent of the babies born were boys. Which hospital do you think recorded more such days?
>
> Check one:
>
> a) The larger hospital.
> b) The smaller hospital.
> c) About the same (i.e., the number of days were within 5 percent of each other).

Fifty-six percent of subjects (Stanford University undergraduates) judged the probability of obtaining more than 60 percent boys to be the same for both the small and large hospital, presumably since these events are represented by the same statistic and therefore are equally representative of the general population. Subjects employing the representative heuristic in this example failed to consider the fundamental principle of sampling--namely that the error in a sample becomes smaller as the sample size gets larger. Thus, the deviation of 10 percent or more from the 50 percent proportion in the population is more likely when the sample size is small.

In general, the reliability heuristic can be more simply thought of as "what is out of sight is out of mind." In other words, individuals rely almost exclusively on specific information that is provided with little or no regard to factors that limit the predictive accurary of the information such as small sample size and unreliability of the information. Prior probabilities or base rates which summarize what a person knew before receiving the evidence specific to the case at hand and which remain relevant even after specific evidence is obtained, are also "out of sight." The representative heuristic can play an important role when hiring new job applicants. In predicting who will succeed in a given position, the job applicant who performs best during a 30-minute interview is often times selected over one who performs poorly, regardless of the limited reliability of the interview process and the limited material that is covered in the interview.

Anchoring and Adjustment

A third heuristic that serves to ease the strain of information processing has also been identified by Tversky and Kahneman (1972). This

heuristic is employed in numerical predictions when a relevant value is available. Specifically, a natural starting point or anchor is used as the first approximation to a judgment. The person then adjusts this anchor to accomodate the implications of additional information. In general, different starting points yield different estimates which are biased towards the initial values. Tversky and Kahneman (1974) demonstrated the use of this heuristic in a study where subjects were asked to estimate various quantities that were stated in percentages (e.g. what is the percentage of people in the U.S. today who are 55 or older?). Subjects were given starting percentages that were randomly chosen and were asked to adjust these percentages until they reached their best estimate. Subjects whose starting points were high ended up with higher estimates than those who started with low values.

Anchoring has been found to occur not only when subjects are given a starting point but when the subject bases his estimate on the result of some incomplete computation. Two different groups of high school students (Tversky and Kahneman, 1972) were asked to estimate the product of either 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 or 1 x 2 x 3 x 4 x 5 x 6 x 7 x 8 within 5 seconds. To perform this task rapidly, people compute the first few steps and then estimate the product by extrapolation or adjustment. Tversky and Kahneman hypothesized that since adjustments are typically insufficient, the procedure should lead to underestimation in both cases. Furthermore, since the first steps of multiplication yield a product higher in the descending than ascending sequence, subjects should judge the product of the first expression to be higher in the descending sequence. Results confirmed both predictions. While the correct answer to the problem is 40,320, (8!), the median estimate for the ascending sequence was 512, and 2250 for the descending sequence.

Overconfidence in Judgments Based on Heuristics

The preceding studies demonstrate the use of heuristics in making a decision. Research has also found that individuals have too much confidence in judgments based upon these heuristics (Fischhoff, Slovic, & Lichtenstein, 1977; Lichtenstein, Fischhoff & Phillips, 1977).

In a follow-up study on the causes of death, subjects were asked to indicate the odds that they were correct in choosing the more frequent of the two lethal events (Fischhoff, Slovic & Lichtenstein, 1977). About one out of every eight answers were wrong where subjects had given odds of 100:1 or greater that they were correct. The psychological basis for this unwarranted certainty, according to Fischhoff and his colleagues, is an insensitivity to the tenuousness of the assumptions on which judgements are based. For example, the extreme confidence in the incorrect assertion that homicides are more frequent than suicides may occur because individuals do not appreciate the greater ease of recalling instances of homicides as an imperfect basis for inference.

Other studies have demonstrated that people think they can estimate uncertain quantities with much greater precision than they actually can. Hynes and Vanmarcke (1976) asked seven internationally known experts to predict the height of an embankment that would cause a clay foundation to fail and to specify confidence bounds around their estimates that would have a 50 percent chance of enclosing the true failure height. None of the bounds specified actually enclosed the true failure height.

Risk-Averse or Risk-Seeking Decisions

Tversky and Kahneman (1981) have recently expanded their work on individual decision making to include how people feel about making

decisions that involve risk of loss as well as opportunity for gain. Risk-averse and risk-seeking decisions are defined by the way in which individuals evaluate the outcomes of a problem. In other words, given two choices of equal expected value, a risk-averse decision will be one in which the riskless or certain prospect is preferred over the risky prospect of equal or greater expected value. In contrast, a risk-seeking decision is one in which the risky prospect is preferred to a riskless prospect of equal expected value. Buying insurance is an example of making a risk-averse decision. An individual prefers the sure loss of a small amount of money (i.e., paying the premium) to the prospect of a larger loss with an associated small probability.

Tversky and Kahneman have shown that normatively inconsequential changes in the formulation of decision problems significantly affect a decision maker's preferences for risk-aversion or risk-seeking. A reversal in preferences was found when the following pair of problems was given to separate groups of subjects comprised of students at Stanford University and the University of British Columbia. The total number of subjects answering the questions is denoted by N, and the percentage who chose each option is indicated in brackets.

> Problem 1 [N = 152]. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimate of the consequences of the programs are as follows: If program A is adopted, 200 people will be saved. [72 percent] If program B is adopted, there is a one-third probability that 600 people will be saved, and two-thirds probability that no people will be saved. [28 percent]
>
> Which of the two programs would you favor?

The results indicated that subjects were risk-averse. In other words, the prospect of saving 200 lives with certainty was more attrac-

tive than a risky prospect of equal expected value, i.e., one-in-three chance of saving 600 lives.

> Problem 2 [N = 155]. If program C is adopted, 400 people will die. [22 percent]
> If program D is adopted, there is a one-third probability that nobody will die, and two-thirds probability that 600 people will die. [78 percent]
>
> Which of the two programs would you favor?

The results indicated that the majority of subjects were risk-takers, i.e., the certain death of 400 people is less acceptable than the two-thirds chance that 600 will die. While it can be seen that the two problems are essentially identical, in the first problem, the outcomes are described by the number of lives saved while in the second problem, by the number of lives lost. This change results in a pronounced shift from risk aversion to risk taking. The common pattern illustrated in this example, namely that choices involving gains are often risk-averse and choices involving losses are often risk taking, has generalized to a variety of decisions including medical treatment strategies (McNeill, Parker, Sox & Tversky, 1982).

Tversky and Kahneman (1981) have also demonstrated that outcomes that are merely probable are undervalued in comparison with outcomes that are obtained with certainty. The term "pseudocertainty" was coined to describe the effect obtained when an event that is actually uncertain is weighted as if it were certain. For example, Slovic, Fischhoff and Lichtenstein (1982) showed that a hypothetical vaccine that reduces the probability of contracting a disease from 20 percent to 10 percent will be taken less often when described as effective in half of the cases versus when described as fully effective against one of two exclusive and equally probably virus strains that produce identical symptoms. In

other words, subjects valued full protection against an identified virus more than probabalistic protection against the disease.

Stress and Cognitive Performance

As the above review illustrated, the investigations of individual decision-making have yielded numerous demonstrations that subjects employ heuristics. However, Estes (1983) points out that none have gone one step further to attempt to explain conditions under which heuristics do or do not come into play when appropriate.

This study seeks to examine the effects of one condition on the use of heuristics, namely environmental stress. Since no studies have been conducted specifically in this area, one needs to review the literature on the effects of environmental stress on areas of cognitive performance other than inferential judgment tasks, to develop hypotheses for predicting the relationship between stress and heuristics.

In-depth reviews in this area are provided by Hockey (1979), Cohen (1980) and more recently by Cohen, Evans, Stokols and Krantz (1986). Of most interest for this study are the types of environmental stressors studied, the tasks on which the effects of stress were examined and finally, the theories that have been suggested to account for the results. As will be seen, investigators in this research area have identified certain cognitive strategies that subjects use in dealing with or adapting to the stressors.

Effects of Noise on Attention

Most of the cognitive research on stress has used noise as the independent variable or stressor (Cohen et al., 1986). In addition, most of the work on stress effects on cognitive performance has looked at skilled performance, mainly sustained attention and memory. Early

research in the effects of stress on cognitive performance was driven by practical needs of military and industrial organizations which were most interested in human work efficiency. The aim of these studies was to assess which conditions affected efficiency and to provide recommendations for guarding against these effects. These studies primarily used two types of tasks to monitor the effects of stress on one specific area of cognitive performance, namely attending to environmental information.

In the first task, a vigilance task, the subject is required to monitor a stimulus source for a brief signal that has an unpredictable and usually low probability of occurrence. The subject usually is required to sustain visual attention continuously for periods of 30 minutes or more. In a serial reaction time task, the subject is required to respond rapidly to signal cues. Usually these signal cues are lights displayed on a panel. As the light is illuminated, the subject presses a button or metal plate near the light. This action shuts the light off and another light is illuminated.

Cohen et al. (1986) note two types of general effects reported in these studies. Exposure to continuous noise within the range of 80-100 decibles (dB) leads to errors on vigilance tasks (Jones, Smith & Broadbent, 1979; Hockey, 1973; Broadbent & Gregory, 1965). Specifically, subjects make more rapid, less cautious responses, and more false alarms (make more false-positive decisions) and give fewer medium-level confidence ratings of the certainity of their decisions. In other words, subjects become more certain of their responses under noise. Under serial reaction time tasks, where subjects have been primarily exposed to intermittent noise, ranging from 80-110 dB, momentary lapses in task efficiency appear most frequently within 30 seconds of the onset of the

noise bursts (Fisher, 1972; Wilkinson, 1969). Momentary deterioration is usually compensated by subsequent spurts of efficiency. Therefore, when examining overall accuracy, noise effects appear to be either absent or minimal. The research indicates that intermittent noise functions as a distractor on attention tasks.

A third general effect has been noted when subjects are required to observe multiple signals in a "dual task" paradigm. In such a paradigm, subjects are required to carry out two simultaneous tasks. However, they are provided with instructions about what priority to give to each component. When attention must be shared among several "targets," noise causes no deficits on the primary task but does produce errors in the less important task (Boggs & Simon, 1968; Finkelman & Glass, 1970; Hockey, 1970; Evans, 1979). Hockey (1970) concludes that these errors are not perceptual but rather support an attention reallocation explanation. In other words, subjects concentrate on the more important, primary cues at the expense of attending to secondary cues.

Effects of Noise on Memory

Memory is a second area of cognitive performance on which stress effects have been studied. Two types of memory deficits have been identified. Evidence for a deficit in incidental memory is quite consistent from both laboratory and field experiments. In general, incidental memory tasks measure recall or recognition of information that subjects are not explicitly asked to focus on during the experiment. For example, Hockey and Hamilton (1970) found that while noise slightly facilitated the recall of 8-word sequences on slides, noise significantly degraded memory for recall of what corner the word sequence had appeared in the slide. Similar deficits for incidental memory have been found when

crowding was used as stressor (Evans, 1979; Saegert, Mackentosh & West, 1975). In a field experiment, Matthews and Canon (1975) observed a reduced helping effect by subjects who observed an accident adjacent to a lawnmower that was running as opposed to one that was turned off. When an arm cast was added to the confederate observed in this accident, helping behavior increased significantly under ambient conditions. However, under noisy conditions, there was no effect of the arm cast on helping behavior. The authors concluded that the incidental information provided by the arm cast was not salient to observers under noise conditions. These results have been replicated in a laboratory experiment by Cohen and Lazak (1977).

Evidence for a deficit in the processing of more complex information is available, yet less consistent than that for incidental memory deficits. A variety of paradigms and tasks have been used in such studies making it difficult to generalize any findings. Hockey (1979) had subjects learn a fictional prose passage under noisy and quiet conditions. Noise slightly facilitated the recall of names of persons in the passage and significantly damaged comprehension of the story's major themes. Evidence for noise interfering with the processing of meaningful types of information also comes from studies in which subjects' ability to cluster items in meaningful categories is disrupted (Daee & Wilding, 1977; Smith, 1980).

A more general hypothesis has developed from the findings that noise improves the recall of physical characteristics of stimulus materials, but interferes with the processing of complex, meaningful relationships. Stressors are thought to affect encoding strategies during the learning of material. Specifically, noise may produce shallow

encoding (i.e., concentration on physical characteristics such as color, order) at the expense of deeper processing (i.e., semantic interrelationships among materials).

In addition to advancing this depth-of-processing mechanism to explain the differential noise effects on memory, other investigators have suggested that the detrimental effects on comprehension may be a consequence of faster information-processing time during noise periods (Hamilton, Hockey & Rejman, 1977). This increase in information processing speed may lead to a faster throughput of information in working memory and a reduced storage capacity. In other words, contexual or thematic structures may not be held in memory during the faster information processing that happens during noise.

At this time, these mechanisms interrelating faster processing time with better encoding of physical details and poorer comprehension of complex structures are speculative. Evidence has been found for noise improving the learning of order information and information processing time being faster under noise conditions.

The above review has noted the effects of a stressor, specifically noise, on tasks performed during exposure to the stressor. This line of research has resulted from a primary interest in documenting how environmental stress affects task efficiency. Alternatively, a number of studies have examined the effects of stressors on tasks performed upon termination of the stressor.

Aftereffects

These studies incorporate an aftereffects paradigm fashioned after a series of studies first conducted by Glass and Singer (1972). In such a paradigm, a subject is exposed to a stressor condition while

working and asked to complete a variety of tasks in a quiet condition upon termination of the stressor. Common aftereffects tasks include measures of frustration tolerance, concentration, and accuracy.

Glass and Singer (1972) observed that a 25-minute exposure to bursts of loud, unpredictable and uncontrollable noise caused decrements in accuracy and persistence. Cohen (1980) provides an extensive review of the aftereffects studies conducted after 1972. In general, consistent negative aftereffects have been demonstrated after exposure to uncontrollable, continuous noise, particularly on frustration tolerance. Intermittent noise that is unpredictable leads to less consistent patterns across studies (see Cohen, 1980). These results have also been generalized to a variety of both social and nonsocial stressors including crowding, electric shock, cold pressors, a frustrating experience with a bureaucracy and an experience of arbitrary or sex discrimination.

Major Theories Explaining Reported Results

A variety of explanations have been provided to account for the results cited above. Research on sustained attention and on memory has relied on the use of arousal or activation as the major theoretical explanatory construct. These concepts as originally conceived, referred to nonspecific physiological changes in brain activity mediated by the brain stem reticular formation and the diffuse thalamic projection area (Hebb, 1972; Malmo, 1959). Behavioral manifestations of arousal encompassed a range of waking states from low activity levels, such as drowsiness, to high activity levels.

The Yerkes-Dodson law is one of the oldest formulations to show a relationship between arousal and performance. Yerkes and Dodson (1908) discovered that while rats' performance on an easy discrimination task

improved with increasing shock intensity, performance on a difficult task was worse with both weak and strong shocks and optimal with intermediate-level shocks. An inverted U-shaped function was used to describe these results. This function has been applied to human performance as well. In general, optimal performance is associated with moderate levels of arousal. Performance decrements will be seen when the individual is either below (too little activation) or above (too much activation) this moderate arousal range. For several decades arousal was treated as a theoretical concept rather than as a measurable and observable construct. In fact, the most fundamental criticism of the arousal model today, is the lack of clear evidence for unitary physiological activation. Indices of arousal have varied from general muscular activity to sympathetic nervous system activity, to activities in the reticular activating system. Lacey (1967) has debated that there is no single unitary and useful concept of arousal.

Other problems related to the inverted U-shaped function between arousal and task performance concern the mechanisms by which level of arousal predicts task performance. The negative effects of very low levels of arousal (e.g. sleep deprivation) on task performance can be explained by fatigue which can lead to either inability to detect critical cues or being too tired to respond quickly enough.

The mechanisms for explaining the detrimental effects of overarousal were more problematic. Easterbrook (1959) developed the cue-utilization hypothesis to try to better explain the relationship between hyperarousal and performance on complex tasks. He proposed that high levels of arousal narrow the focus of attention so that only the most central cues in a task are attended to. Since complex tasks have, in

general, more cues associated with them than simpler ones do, more of the critical ones necessary for accurate task performance are more likely to be missed, thus leading to poorer performance. Easterbrook noted that in some cases this restriction in attention may actually improve cognitive efficiency. For example, when the excluded cues are irrelevant to the thought process, efficiency will be improved. But, when a task requires attention to a wide range of cues, narrowing of attention will have deleterious effects. Basing predictions on this hypothesis has its problems. Using the theory of an inverted U-shaped function, relating arousal and performance, if deficiences were not found during a stressor, one could conclude either that the stressor was not intense enough, that the task was not complex enough, or both. Poulton has also maintained that overarousal is not detrimental to task performance (Poulton, 1977, 1978, 1979). In addition, controversy exists over the empirical understanding of attentional narrowing or filtering. Easterbrook did not suggest a mechanism whereby heightened arousal leads to this attention narrowing. Furthermore, one does not know if overarousal reduces the amount of information one can process per unit time or whether it affects the strategies selected by the person to solve the task. Hockey's work, mentioned early, seems to produce evidence for Broadbent's theory that in fact the effects of attentional focusing are decisional rather than perceptual. Under heightened noise levels, subjects are believed to pay more attention to important sources of information.

The information overload model of Cohen (1978, 1980) is a second major model used to explain the effects of stressors on human performance. This model assumes that humans have limited information processing capacity. A state of information overload exists anytime the demand for

attention exceeds the total available capacity. Information overload is likely to be created by the presence of an environmental stressor because it requires an allocation of attention. The amount of attention required to monitor such a stressor is a function of its uncertainty, i.e., the more unpredictable and uncontrollable the stressor, the greater the attentional resources needed to "cope" with task demands. The organism copes by allocating the available yet reduced capacity to the more central aspects of the tasks--cues that are most relevant for successfully completing the task.

Among the consequences for this hypothesized reduction in information-processing capacity are 1) the effects of stress (i.e., cognitive fatigue) increase as the duration of the task's demands increases, 2) cognitive fatigue increases with increased task load, 3) given sufficient load demands, cumulative fatigure effects or after-effects may occur after the stressor is terminated. While the first two consequences consistently have been demonstrated (see Evans, 1986), at least one research group (Wohlwill, Nasar, DeJoy & Foruzani, 1976) did not find that task demands affected the cumulative fatigue effects from a noise stressor. Specifically, subjects who listened to noise but did not perform a concurrent task showed the same aftereffects as those who worked on a task while listening to noise. Cohen (1980) suggests that similar aftereffects may have been seen in the two groups, since the instructions to the no-task subjects may have led them to assume they were to process task stimuli.

Cohen et al. (1986) offer another perspective on the relationship between stress and cognitive performance. Rather than using task performance as the outcome measure, Cohen et al. argue that stressors may

alter cognitive processing strategies directly. Changes that occur in information processing activities under stress are considered functional or adaptive to the extent they are related to voluntary attempts to maintain cognitive performance under suboptimal environmental conditions. Task deficits may appear to the extent that the stressor alters the cognitive strategy needed to complete the task.

Cohen et al. identify the following kinds of changes in cognitive strategies that occur in the presence of a stressor (p. 167):

1. Shift in attention toward most dominant (important) cues in a task.
2. Faster processing of information in working memory.
3. Reduced holding capacity in working memory.
4. Better encoding of sequential order of materials in memory if given rehearsal opportunity.
5. Poorer performance after cessation of a stressor on tasks requiring persistence.

Cohen et al. suggest that efforts to alter cognitive strategies and maintain optimal peformance during stress produces physiological effects that are different from those produced directly by the stressor itself. Long-term physiologic and cognitive effects can result from persistent efforts to maintain optimal performance. Support for this mechanism comes from studies that have shown involuntary selective inattention to acoustic cues by individuals who have been chronically exposed to noise (see Cohen et al., 1986).

Hypotheses

Research examining the process by which individuals make decisions indicates that when faced with problems of judging probabilities, making

predictions and more generally, coping with uncertainty, the individual uses judgmental heuristics which serve as general strategies for simplifying complex tasks. Specifically, when using the availability heuristic, the individual will judge an event as likely or frequent if instances of it are easy to imagine or recall. In applying the representative heuristic, probabilities are evaluated by the degree to which features of the target are compared to features of possible outcomes, and the outcome that is more representative of the target is chosen. This heuristic strategy is insensitive to sample size, base rates, reliability of the evidence, and expected accuracy of the prediction. Whether or not an individual is risk-averse or risk-seeking will depend on the formulation of the decision problem. Individuals will be risk-averse on decisions that involve opportunity for gain and risk-seeking on decisions that involve risk of loss. Finally, individuals will undervalue outcomes that are merely probable to those outcomes that are obtained with certainty. Research in this area has also found that individuals are typically overconfident about the judgments that are based on these heuristics. These findings have generalized across different samples of subjects, across tasks involving predictions, probabilities and uncertainty, both in the lab and in the field.

Research examining the effects of stress on cognitive performance has focused primarily on the effects of noise on two aspects of skilled performance, namely attention and memory. While the emphasis has been on task proficiency and efficiency, investigators have identified strategies that individuals use to adapt to the stressor. These include: 1) a shift in attention toward the most dominant cues in a task,

2) faster processing of information in working memory, and 3) a reduction in the use of intermediate categories of confidence.

While the methodologies have differed, both research areas have identified the use of short cutting strategies that individuals use to keep information processing demands of complex tasks within the bounds of their limited cognitive capacity. The latter research area suggests that these strategies may serve to mediate the effects of stress on skilled performance. However, few investigators have actually examined the strategies that subjects use while performing tasks during the presence of a stressor.

This study serves to integrate the two areas in the following way. Research on heuristics provides judgmental tasks that can be used to study the effects of stress on decision making. The literature reporting the effects of stress on cognitive performance shows that unpredictable and uncontrollable environmental stressors have yielded consistent negative effects on tasks designed to measure frustration tolerance and concentration. This study will employ an unpredictable and uncontrollable stressor and note its effects on the use of heuristics. The study will serve as a general test for the existence of a relationship between stress and decision making rather than as a means for differentiating among the specific mechanisms reviewed above. The following hypotheses will be tested.

1. A decision maker's need to simplify information-processing tasks should become more urgent when he/she must operate under stress. Therefore, it is hypothesized that subjects exposed to an uncontrollable and unpredictable stressor will use more heuristics (i.e., increased use of

short-cutting strategies) than subjects in the non-stressed control group.

2. Exposure to the stressor will also produce aftereffects. Increased use of heuristics as well as decrease in frustration tolerance are predicted as aftereffects for stressed subjects versus the non-stressed control group.

3. Exposure to noise has been found to reduce the number of medium level confidence ratings used by subjects regarding the certainty of their decision. Therefore, subjects in the stressed groups will use more extreme judgments of confidence than those subjects in the non-stressed control group.

Chapter 2

Decision-Making Instrument Construction

Evidence for the use of heuristics, or short-cutting strategies, has been demonstrated by individuals responding in similar ways to a variety of questions originally developed by Tversky and Kahneman. The responses to these questions have documented quite conclusively, the existence of a variety of heuristics. However, the findings provide no information regarding the correlations between questions measuring the same heuristic, or correlations between questions measuring different heuristics. Furthermore, the questions have not been used to measure an individual's consistent use of heuristics. Since one of the major dependent variables to be used in the study was the number of heuristics employed by subjects in a stressed vs non-stressed group, a questionnaire was developed to assess these three relationships. It encompassed the four different heuristics known as availability, representativeness, certainty and risk taking.

Instrument Development and Administration

A total of 26 items constituted the item pool of the decision-making instrument (see Appendix A). While the various heuristics have been shown to play an important role in a variety of probability judgments, e.g., medical judgments (see Kahneman, Slovic & Tversky, 1982), the items selected for the instrument were essentially restricted to situations where objective probabilities could be computed. Eleven of the items tapped the availability heuristic, six the representativeness heuristic, one the certainty heuristic, and eight the risk taking heuristic. Risk taking was divided into four questions assessing risk

aversion and four assesing risk seeking. Questions were ordered such that no two consecutive questions involved the same heuristic. Efforts were made to develop an instrument that would take approximately half an hour to complete.

In Table 1, the 26 items are categorized according to the heuristic to which conceptually they belong. The source of each of the questions is also provided. Items were drawn from a series of different studies. Tversky and Kahneman (1973) reported that approximately 1500 subjects participated in total in these studies. Individual studies were conducted in groups of 20-40 subjects. Subjects included students from the University of Oregon, the University of British Columbia, Stanford University, and tenth and eleventh grade students of several college preparatory high schools in Israel. Questionnaires comprising a small number of (usually 2-4) questions were administered in quiz-like fashion in a natural classroom situation. Subjects were required to record their names on the answer sheets. The questions were presented "as a study of people's intuitions about chance" (Kahneman and Tversky, 1972).

In the present research all 26 items were included in one questionnaire. The questionnaire was administered to 100 undergraduates from local universities. The sample consisted of 50 men and 50 women with a mean age of 22.7 years. The mean time needed to complete the questionnaire was 24 minutes. Instructions for completing the questionnaire were included in a cover sheet. The questionnaire was described as a measure examining how individuals respond to a number of topics when they do not have all the information at their fingertips. In addition, subjects were told that their responses would help in developing

a final questionnaire examining intuitions about chance. Unlike subjects in original studies who were asked to record their names on their answer sheets, respondents in this research were told that their answers would be anonymous, and were in no way a reflection of their intelligence, personality, or character.

Results and Discussion

For each item, a subject received a score of 1, used the heuristic in solving the problem or 0, did not use the heuristic (see Table 1 for scoring key). The scoring of items was based on comparable findings reported by the originators of each of the questions. A major limitation of the original, as well as present, research is that the use of heuristics is inferred from the outcome. A better approach for future studies might require the individual to select one response from a number of alternatives that reflect either heuristic use, objective frequency or probability, or pure guesses.

Figure 1 illustrates the frequency of heuristics used across the sample. The number of heuristics used by the sample ranged from a low of 6 or 23 percent of the total to 23 or 85 percent of the total. The mean number of heuristics used by the sample was 16 out of 26 or 61 percent. The percentage of subjects using heuristics in this study as compared to the original studies is provided in Table 1. While several of the "heuristic" alternatives (Items 3, 5, 10, 14, 15, 18, 19) are endorsed at levels not much greater than chance, for the most part, the present results replicate previous findings. Specifically, on 8 of the 12 items for which percentages are available from this study, as well as the original study, the majority of subjects used heuristics in making their decisions. In addition, while percentages were not reported for

items 20-24 in the original study, as was found in the Lichtenstein et. al. (1978) study, rare causes (e.g., fires) were overestimated and common causes were underestimated (e.g., diabetes). The rare causes that were overestimated were dramatic and sensational.

Differences that were found for the certainty heuristic between this study and the original research could have been due to the way the item (i.e., Item 11) was presented. In the original research, Slovic, Fischhoff, and Lichtenstein (1982) presented Item 11 as two separate questions to two different samples of subjects. They found that 57 percent of their first sample were willing to volunteer to be vaccinated if the vaccine was presented as being effective against one of two exclusive and equally probable virus strains. When the question was phrased such that the vaccine would reduce the probability of contracting a disease from 20 percent to 10 percent, only 40 percent of a second sample were willing to volunteer to be vaccinated. Even though two different samples answered these questions, the authors concluded from these results, that individuals undervalue a reduction in the probability of a hazard in comparison to the complete elimination of risk. In the present sample, a score of one was given if the respondent's certainty of being vaccinated was greater for elimination of risk vs reduction of risk. In the majority of cases, respondents in the present sample, answered that they were equally likely to be vaccinated if the vaccine reduced the risk or completely eliminated the risk.

In addition to determining whether the present sample results replicated the results of previous studies on an item by item basis, it was also of interest to determine the internal consistency of the items. Because the data were in dichotomous form, the internal consistency of

the items are reported as reliability coefficients KR-20 (Kuder-Richardson-20), a measure analogous to Cronbach's α (Cronbach, 1951). Reliabilities for the different heuristic categories, as well as the total 26 items, are presented in Table 2. As can be seen, only the items measuring risk aversion and risk seeking were internally consistent, with KR-20 coefficient reliabilities of .68 and .65, respectively. The KR-20 coefficient reliability for the scale as a whole was .18. Reliability coefficients for the availability and representative heuristics were .22 and .23, respectively. Further analyses were conducted to determine correlations between items tapping each of the heuristics and the rest of the items. Such analyses revealed significant negative correlations between items on the risk aversion scale and risk seeking items. Specifically, risk aversion correlated negatively with Item 2 ($\underline{r} = -.24$, $\underline{p} = .02$), Item 13 ($\underline{r} = -.15$, $\underline{p} = .14$), Item 16 ($\underline{r} = -.38$, $\underline{p} < .001$) and Item 26 ($\underline{r} = -.33$, $\underline{p} = .01$). Similarly, the risk seeking scale correlated negatively with items on the risk aversion scale (i.e. Item 6 ($\underline{r} = -.11$, $\underline{p} = .26$), Item 9 ($\underline{r} = -.34$, $\underline{p} < .001$), Item 18 ($\underline{r} = -.19$, $\underline{p} = .08$), and Item 25 ($\underline{r} = -.21$, $\underline{p} = .05$)). In general, the risk aversion scale correlated negatively with the risk seeking scale ($\underline{r} = -.36$, $\underline{p} < .001$).

Exploratory analyses were also conducted to determine whether reliabilities of the different heuristic "scales" could be improved by dropping poorly discriminating items, i.e., those items on which approximately only fifty percent of the present sample used the heuristic. Specifically, Items 1, 3, 5, 10, 14 and 24 were dropped from the availability scale, Items 15 and 19 from the representative scale, and Item 18 from the risk-aversion scale. All the above items plus Item 11 were

dropped to compute the new reliability coefficient for the total instrument. Such analyses revealed no significant changes in the reliability coefficients. Results of the analyses are provided in Table 2.

The results of the reliability analyses suggest that the conceptional relatedness ascribed to the availability and the representativeness heuristics do not hold up statistically. Further research is needed to determine why such discrepancies exist. A discussion of reasons for these discrepancies is included in Chapter 5. For purposes of the study described in Chapter 3, these items will be analyzed on an individual basis. In addition, findings will be reported for items comprising the risk-aversion and risk-seeking scales.

Chapter 3

Method

Overview

Two experiments were conducted in parallel fashion. The purpose of the first experiment was to examine the effects of an environmental stressor on decisions made while exposed to that stressor. The second experiment examined if there were any effects on decision-making after the environmental stressor had been terminated. The environmental stressor used in both experiments consisted of noise bursts of 105 dB(A) delivered free-field through a speaker system. The stressor was designed to be unpredictable in that noise bursts of random length were inserted within random length intervals of silence, per the schedule described by Glass and Singer (1972). Specifically, each minute of the total noise period was divided into four parts. Noise bursts were randomly assigned to a different part in each one minute segment. The length of the noise bursts was also varied in random fashion, with a mean burst duration of 9 seconds and a range from 3 seconds to 15 seconds. The stressor was also uncontrollable in that subjects could not turn off the noise or leave the room. Subjects were exposed to approximately 25 minutes of this random intermittent noise at 105 dB(A). The subject's total exposure to noise amounted to five minutes.

Subjects

Sixty-eight undergraduate and graduate students (34 men, 34 women) recruited from local universities took part in the two experiments. Subjects responded to an advertisement describing a study examining the effects of environmental conditions on information processing. Subjects

were limited to full-time students who did not report having high blood pressure, were not taking any medications for hypertension and did not have any hearing loss. Subjects' ages ranged from 18 to 32 with the mean age being 22.2 years. All subjects were paid $15.00. Four subjects' data were eliminated for the following reasons: 1) two because of failure of the physiological recording apparatus; 2) one because of misunderstanding the directions for doing the frustration-tolerance task; and 3) one because of familiarity with the frustration-tolerance task.

Procedure for Experiment One

Thirty-two subjects were randomly assigned to one of the two conditions described below. Measures identified within the procedure sections are described in more detail under "Dependent Measures."

Unpredictable-uncontrollable stress condition. On entering the lab, each subject was ushered into a 7' x 10' x 7' sound-attenuated chamber where he/she took a seat behind a table. The experimenter described the purpose of the study as being "to study how different environmental conditions affect the way that people process information. The environmental condition we are specifically interested in, is that of noise. We want to study the effects of different noise levels on your performance of some verbal and numerical tasks. While you are working, you will hear loud noises over that speaker from time to time. We are interested in how distractions of this nature affect the quality of your work. In addition, research has shown that physiological responses correlate with mental performance. Therefore, we will be monitoring your blood pressure and heart rate while you work on the tasks. You will feel the cuff inflate and deflate automatically every few minutes."

At this point, after receiving the subject's verbal consent to continue with the experiment, the experimenter placed the blood pressure cuff around the subject's nondominant arm. The experimenter then explained the consent form and the mood checklist. While subjects completed the forms, the experimenter recorded, in an adjacent room, three blood pressure and heart rate readings over approximately a ten minute period.

After the baseline physiological measures were obtained, the experimenter re-entered the chamber to explain the tasks. The task consisted of completing the questionnaire (hereafter referred to as the decision-making task) in Appendix A. Subjects were told that the questions were compiled to represent a variety of tasks ranging from simple to complex. Subjects were told that if they did not know an answer, to guess rather than leave an item blank. Subjects were also told to answer the questions in order and not to go back to an item once a response had been made. Subjects were told that blood pressure readings would be taken while they worked on the task. By means of an intercom between the sound chamber and control room, the experimenter told the subject when to begin the task. The experimenter recorded blood pressure and heart ratings readings every two minutes during the task period. A final reading was obtained while the subject completed the second mood checklist.

The experimenter re-entered the sound chamber, collected the materials, and explained the directions for completing a questionnaire assessing coping strategies. After the subject completed this questionnaire in private, the experimenter informed the subject that Part I of the study was over and that there was to be no more noise and no more blood pressure readings. The blood pressure cuff was removed from the

subjects' arm. At this point, the subject was informed of the post noise, Part II measure described under "Tolerance for Frustration," in the next section. Following completion of this task, the subject completed a final mood checklist and a brief questionnaire assessing the subject's reaction to the experimental conditions. Subjects were then debriefed and paid for their participation.

No stress condition. Subjects in this condition completed the decision-making task without being exposed to the stress manipulation. In this condition, the purpose of the study was modified as follows: "The purpose of today's experiment is to study physiological correlates of your performance on verbal and numerical tasks. While you are working, we will monitor your blood pressure and heart rate while you work on the tasks." In every other respect, the procedure was identical to that used in the stress condition.

Procedure for Experiment Two

Thirty-two subjects were randomly assigned to one of the two conditions described below.

Unpredictable-uncontrollable stress condition. This stress condition was identical to the first stress condition described in Experiment One with the two following exceptions: 1) subjects worked on three standardized tests of cognitive performance while being exposed to the noise and, 2) subjects worked on the decision-making task during the post noise, Part II period. The three tests (see Appendix B) were adapted from those used in the Glass and Singer (1972) study. They were: a) an addition task in which the subject added columns of three 1- and 2-digit numbers; b) a number comparison task, in which the subject indicated whether a pair of multi-digit numbers was the same or different;

and, 3) a finding A's task in which the subject was to put a line through all words in each column of 41 words having the letter "a" in them. Subjects were told to work as quickly as they could on each task without sacrificing accuracy. By means of the intercom, the experimenter told the subject when to stop working on the first test and go on to the subsequent tests. Subjects were given eight minutes to work on each test.

No-stress condition. Subjects in this condition completed the three tests without being exposed to the noise. Otherwise, the procedure was identical to that used in the stress condition.

Dependent Measures

Stress Manipulation Cecks. On a post-experimental questionnaire (see Appendix C), subjects were asked to evaluate the environmental conditions, specifically their reaction to the noise, or lack of, by responding to four questions. On a seven point Likert-type scale, they were asked to rate the degree of irritation, unpleasantness and distraction they felt. On the fourth question, subjects were asked to rate the difficulty of the experimental task (task performed in Part I of the experiment).

The Multiple Affect Adjective Checklist (MAACL) (see Appendix D) (Zukerman and Lubin, 1965) was used to measure a subject's self-report of anxiety, depression and hostility at three different time periods, namely prior to beginning the task (baseline), immediately after working on the experimental tasks, and shortly before debriefing. The MAACL is designed to measure differences in states versus traits. The subject is asked to check adjectives that describe how he/she is feeling at the moment. The

highest scores obtainable are 21 for anxiety, 39 for depression and 28 for hostility.

Physiological measures also served as a check to determine the effectiveness of the manipulation. The Spacelabs® Automatic Blood Pressure Monitor was used to record subjects' systolic and diastolic blood pressure and heart rate every two minutes. Three readings were taken during the baseline period or until systolic blood pressures remained relatively consistent (± 3mmHg) across two successive sample periods. Physiological data were collected every two minutes throughout Part I of the two experiments. One post experimental measure was obtained while the subject completed the second mood checklist.

Cognitive Performance Tests. The decision-making task given in Experiment 1 and 2 was the same one described in Chapter 2. Each item was scored as a 1 if the subject answered it using a heuristic or 0 if he/she did not. A total score for the entire decision-making task was obtained for each subject, ranging from 0, did not use any heuristics to 26, used heuristics on the total number of questions.

The standardized tests used in Experiment 2 were scored with respect to total number of items completed in each task, and number of errors made. The addition task consisted of 120 problems (2 pages of 60 problems), the number comparison consisted of 82 identical pairs (3 pages of 24, 28 and 30 identical pairs, respectively) and the finding A's task consisted of 40 columns of 200 words with the letter "A" in them (8 pages of 5 columns).

Confidence Ratings. On twelve of the 26 items of the decision-making task, subjects were asked to rate how confident they were in their answers. Two different scales of confidence were employed. On six

of the items (Items 1, 3, 4, 5, 7, 10, 14) a scale from 1 = very sure to 5 = not sure at all was employed. On five of the items (Items 20-24), subjects were asked to indicate their confidence by the odds that their answer was correct. A scale ranging from 1:1 designating very unsure to 1,000,000:1 designating very sure was provided as a gauge for subjects' responses. Subjects' responses on the last five items were transformed to a 5 point scale, such that odds of 10:1 or less were rated as 1 or very unsure and odds of 100,000:1 or greater were rated as 5 or very sure. Confidence ratings given on the first six items mentioned above were recoded such that anchors were reversed to be consistent with the latter scale.

Coping Strategies. The "Ways of Coping Inventory" (Folkman & Lazarus, 1980) (see Appendix E) was used to measure coping strategies that subjects used while working on the experimental task. The inventory consists of 68 items that describe either problem-focused or emotion-focused strategies for dealing with situations. Items range from "I just concentrate on what I have to do next" (problem-focused strategy) to "I hope a miracle will happen" (emotion-focused strategy). The set of problem-focused strategies provides an estimate of the individual's attempts to directly confront the problem. The second set provides an estimate of the individual's attempts to regulate his/her emotional responses during exposure to the problem. The subjects were told that their answers should relate specifically to the experimental task and the conditions under which they had to perform. Each subject received a score relating to the total number of coping strategies used, the number of problem-focused strategies and the number of emotion-focused strategies.

Tolerance for Frustration. The postnoise task (used in Experiment 1) measuring persistence or frustration tolerance, was adapted from one used by Feather (1961) and subsequently used by Glass and Singer (1982). The task consisted of four line diagrams printed on 5" x 8" cards arranged face down in four piles (30 cards high) in front of the subject. The task was to trace over all of the lines of a diagram without tracing over any line twice and without lifting one's pencil from the figure. The subject was informed that he/she could make as many attempts as desired on a diagram. Once, however, he/she decided to move onto a subsequent diagram, he/she could not return to a previous one. The subject was told to use a new card each time he/she made an attempt.

While subjects worked on the puzzles, the experimenter was in the control room observing and recording the number of attempts made on each puzzle. The number of attempts made on the second puzzle (i.e. the first insolvable one), was interpreted as a measure of persistence, namely, the fewer the number of attempts, the less the persistence and the lower the subject's frustration tolerance. After working on the third puzzle, the subject was informed to stop. This modification in procedure was to conserve the limited time that the subject was available for the experiment; previous studies have shown consistent effects for group differences on the first insolvable puzzle.

Chapter 4

Results

Overview - Experiment One

Analyses were intended to identify whether or not a relationship existed between stress and decision-making. Results for experiment one will be reported first. In experiment one, psychological, behavioral and physiological indicators of stress were analyzed to examine differences between groups making decisions while exposed to a stressor versus those making decisions in a noise free environment. *t*-tests were used to analyze group differences on measures assessed at one time only. Repeated measures analyses of variance were used to analyze self-report mood ratings and physiological data.

Specifically, analyses were intended to confirm or reject the following hypotheses:

1) Subjects exposed to an uncontrollable and unpredictable stressor would use more heuristics than subjects in the non-stressed control group.
2) Subjects in the stressed group would use more extreme judgments of confidence than those subjects in the non-stressed control group.
3) Exposure to the stressor would produce aftereffects. Therefore, stressed subjects would persist less on the frustration tolerance task than subjects in the non-stressed control group.

Before describing the results of the analyses conducted to examine these group differences, comparability of the groups was assessed with regard

to demographic variables. Secondly, the effectiveness of the stress manipulation was examined.

Comparability of Groups

Comparisons of the stressed versus non-stressed control groups along demographic variables indicated that the two groups were comparable. *t*-tests performed on age and education showed no significant differences between the two groups. The two groups were matched for numbers of males and females (8 of each per group) and time of administering the experiment. No significant correlations between the background variables and dependent measures were found, except for sex. Females had significantly lower systolic blood pressure than males ($t = -4.17$, $p < .001$), significantly higher self-report ratings of anxiety ($t = 2.11$, $p = .04$), and item difficulty ($t = 2.50$, $p = .02$), and made significantly more attempts on the frustration-tolerance task ($t = 2.08$, $p < .05$). Therefore, sex will be treated as a second independent factor where appropriate.

Stress Manipulation Check

The effectiveness of the stress manipulation was determined by examining three different types of data, namely ratings of environmental conditions, self-reported mood data, and physiological data. At the end of the experiment, all subjects were asked to respond to the following items: 1) "The noise I heard while working on the tasks was": 1 = "extremely relaxing" and 7 = "extremely irritating," and 1 = "extremely pleasant" and 7 = "extremely unpleasant;" 2) "To what extent was the noise you heard distracting?" where 1 = "the noise made it extremely easy to concentrate" and 7 = "the noise made it extremely difficult to concentrate;" and, 3) "How easy were the tasks": 1 = "extremely difficult" and 7 = "extremely easy."

Mean ratings to each of these questions are provided in Table 3. Subjects exposed to the noise reported the environmental conditions to be significantly more irritating, unpleasant and distracting ($p < .001$). Subjects exposed to the noise also reported the decision-making task to be significantly more difficult than those working under quiet conditions ($p < .05$). In addition, females reported the task to be significantly more difficult than males, $F(1,28) = 6.9$, $p = .01$.

Similar findings were produced by comparing the two groups on the three scales of the MAACL. Mean ratings of anxiety, depression and hostility for both groups are provided in Table 4. The two groups had comparable baseline ratings on depression and hostility. The noise group reported being significantly more anxious at baseline than the control group ($p < .02$). However, baseline anxiety did not correlate significantly with any of the other dependent measures. This difference could be a result of receiving slightly different descriptions of the study. Repeated measures analysis of variance revealed main effects due to the noise on both anxiety, $F(1,28) = 10.79$, $p < .01$ and hostility, $F(1,28) = 4.04$, $p = .05$ ratings. Main effects for time were found across all three scales (for anxiety, $F(2,60) = 3.05$, $p = .05$; for depression, $F(2,60) = 12.62$, $p < .001$; and for hostility, $F(2,60) = 24.04$, $p = < .001$. In other words, subjects in both the noise and control group reported their highest levels of anxiety, depression and hostility following the completion of the decision-making task. This finding suggests that the task itself may have been stressful. A third main effect for sex was found for the anxiety data only. Specifically, females reported being more anxious than males, $F(1,28) = 4.3$, $p < .05$].

Physiological data for the two groups is presented in Figure 2. Both groups had comparable baseline systolic blood pressure and heart rates. Since the baseline diastolic blood pressure of the noise group was significantly lower than that of the controls, baseline diastolic blood pressure was used as a covariate in the repeated measures analyses. Repeated measures analyses of variance revealed effects for condition for both heart rate and diastolic blood pressure. The control group had significantly higher heart rate, $F(1,29) = 4.63$, $p < .05$ and higher diastolic blood pressure, $F(1,29) = 3.19$, $p = .09$ than the group exposed to the noise. While not significant, the same trend is seen for systolic blood pressure as well. Sex differences were found only for systolic blood pressure. Females had significantly lower systolic blood pressures than males, $F(1,28) = 13.24$, $p < .001$.

In summary, the stress manipulation was effective. Subjects in the noise group rated the environmental conditions to be more aversive and the task to be more difficult than the control group. Similarly, subjects in the noise group reported higher ratings of anxiety and hostility than the control group. Physiological responses of the two groups appear anomalous in that subjects not exposed to the noise showed overall greater levels of sympathetic arousal. However, since no previous studies using this paradigm have measured physiological responses while subjects were performing the task, it is difficult to assess the generalizability of the present findings.

Use of Heuristics

As mentioned above, of major interest to the study was the effect of stress on decision making. The dependent measure used to analyze such an effect was the use of heuristics within each condition. t-tests

conducted to examine group differences on individual items revealed no significant findings. Frequency of use of heuristics across subjects for the two conditions is provided in Figure 3. As can be seen from Figure 3, out of a total of 26, subjects in the noise group used an average of 15 heuristics, ranging from a low of 11 to a high of 21 in their use of heuristics. In the control group, the mean was 16 with a range from 10 to 21. While it was predicted that stressed subjects would use more heuristics across all items, t-tests revealed no significant differences in terms of the groups' overall use of heuristics. Noise subjects used heuristics on 58 percent of all items while the control group used heuristics on 61 percent of all items. In examining the risk-aversion (i.e., Items 6, 9, 18, and 25) and riskseeking (i.e., Items 2, 13, 16, and 26) scales for condition and sex effects in a 2 x 2 analysis, females tended to be more risk-seeking, $F(1,28) = 2.37$, $p = .13$. Specifically, females reported being risk-seeking on three of the four items, while males were risk-seeking on two of the four items. No other effects were revealed.

Confidence Ratings

t-tests were used to analyze whether greater confidence was associated with those subjects completing the decision task under noise versus no noise. Mean confidence ratings given for all 12 items was 2.8 out of 5 for the noise group and 2.5 for the control group. While this difference was not significant ($t = 1.58$, $p = .12$), the direction was in keeping with the hypothesis that the noise subjects would be more confident in their responses than those in the control group.

Further analyses were conducted to determine whether the use of heuristics was related to greater confidence as has been suggested in

the decision-making literature. In examining the frequency of use of heuristics on all 12 items, only items 1, 3, and 5 had fairly even distributions among subjects with respect to a heuristic/no heuristic breakdown. A two-way analyses of variance on condition by heuristic for confidence ratings on these items revealed a marginal main effect for noise on item 3 only. Subjects working while exposed to noise reported greater confidence in their answers (M = 2.9) than those in the control group (M = 2.5), $F(1,28) = 2.93$, $p = .10$. Both heuristic users and non-heuristic users reported a confidence rating of 2.7 on the 5 point scale.

Coping Data

The "Ways of Coping" Inventory was analyzed to determine if exposure to a stressor was associated with different types of coping strategies and whether the use of heuristics specifically correlated with either problem-focused or emotion-focused coping strategies. As can be seen from Table 5, the two groups did not differ in terms of the total number of coping strategies used or the number of problem-focused strategies. The group exposed to the noise used significantly more emotion-focused coping strategies than did the control group ($t = 2.28$, $p = .03$). Pearson correlations examining coping strategies with total number of heuristics as well as the individual categories of heuristics revealed no significant correlations between the use of heuristics and type of coping strategy employed. A significant positive correlation was found for anxiety and emotion-focused coping. Specifically, the higher the rating of anxiety both at baseline and after working on the decision-making task, the greater use of emotion-focused coping strategies ($r = .34$, $p = .05$; $r = .30$, $p = .09$, respectively).

Behavioral Aftereffects

While no effects on performance during exposure to the stressor were found, effects after the stressor was terminated were found. The total number of attempts taken by both groups in trying to solve the insolvable puzzle of the tolerance frustration task was compared to determine whether there were any aftereffects resulting from exposure to the stressor. Because sex correlated significantly with the number of attempts, a 2 x 2 analysis of variance was used to determine both condition (stress) and sex differences. The mean number of trials spent on the insolvable puzzle is provided in Table 6. As predicted, males who had been exposed to the stressor persisted significantly less than those in the control group. Females persisted on the task, regardless of whether they had been exposed to the noise or not. Females persisted significantly more than males on the task, $F(1,27) = 4.12$, $p = .05$. There was also a marginally significant condition x sex interaction, $F(1,27) = 3.7$, $p = .06$. Duncan range tests revealed ($p < .05$) that the number of attempts taken by the males in the stress group was significantly less than the number of attempts taken by subjects in the other three groups.

Overview - Experiment Two

As previously mentioned above, this research was interested not only in examining the effects of an environmental stressor on decisions made while exposed to that stressor (Experiment 1), but also in examining if there were any effects on decision making after the environmental stressor had been terminated (Experiment 2). Much of the data collected in Experiment 2 is the same as that which was collected in Experiment 1. Therefore, analyses were intended again to determine if groups were ini-

tially comparable on background variables and if the stress manipulation was effective. The major differences between Experiment 1 and 2 were: 1) subjects worked on three "filler" tasks while exposed to the stressor and, 2) subjects worked on the decision-making task after exposure to the stressor. Analyses were conducted to determine if there were group differences on performance of both the filler tasks and decision-making tasks. Since noise has shown to have no effects on simple task performance, no differences between the groups were predicted on the filler tasks. However, it was predicted that just as exposure to the stressor would produce a decrease in frustration tolerance, it should also lead to persistent deficits and therefore, an increase in use of heuristics.

Comparability of Groups

As in Experiment 1, both groups were comparable along the demographic variables of age and education. The two groups were matched for number of males and females (8 of each per group) and time of administering the experiment. As in Experiment 1, no significant correlations between the background variables and dependent measures were found, except for sex. Females had significantly lower systolic blood pressure ($t = -3.23$, $p = .003$), and were more risk-averse ($t = 2.26$, $p = .03$) than males.

Stress Manipulation Check

Mean ratings for both groups to each of the four questions described in the results section of Experiment 1, entitled "Stress Manipulation," are provided in Table 7. Subjects exposed to the unpredictable and uncontrollable noise reported the environmental conditions to be significantly more irritating, unpleasant, and distracting ($p < .001$). Unlike subjects in the noise group in Experiment 1, who

reported the task to be more difficult than the control group, there were no differences between mean ratings of task difficulty for the two groups in Experiment 2. These results reflect differences between the tasks that were performed in Experiments 1 and 2. In Experiment 1, the decision-making task was cognitively complex and demanding whereas in Experiment 2, the tasks were repetitive and simple, and subjects did not find it more difficult to perform them while exposed to the noise.

In comparing the two groups on the three scales of the MAACL, both groups were comparable along baseline ratings of anxiety, depression and hostility. Repeated measures analyses of variance revealed main effects due to time only (see Table 8). In other words, both groups reported their highest ratings of anxiety, $\underline{F}(2,60) = 5.10$, $\underline{p} < .01$, depression, $\underline{F}(2,60) = 13.42$, $\underline{p} < .001$, and hostility, $\underline{F}(2,60) = 15.5$, $\underline{p} < .001$ after working on the task. There were no significant differences between the groups.

Physiological data for the two groups is presented in Figure 4. Baseline measures of systolic and diastolic blood pressure and heart rate revealed no differences between the two groups. Furthermore, there were no significant differences between the groups either during the tasks or at the end of the task. A main effect for time was found for diastolic pressure, $\underline{F}(2,54) = 5.32$, $\underline{p} < .01$ with both groups showing the greatest diastolic blood pressure while working on the task. Both groups also showed the greatest heart rates while working on the task, $\underline{F}(2,50) = 3.00$, $\underline{p} = .06$. A main effect on systolic blood pressure and a marginal effect on heart rate was found for sex. Females had lower systolic blood pressure, $\underline{F}(1,27) = 10.10$, $\underline{p} = .004$, and higher heart rates $\underline{F}(1,25) = 3.12$, $\underline{p} = .09$ than males. While there were no significant

differences between the groups, on all three measures of sympathetic activation, as can be seen in Figure 6, higher measures were obtained from the noise group than the control group.

In summary, the stress manipulation resulted in subjects in the noise group rating the environmental conditions as being significantly more aversive than the control group. Group differences were not observed on either mood ratings or physiological measures. In comparison to baseline levels, both groups showed increases in physiological arousal while performing the filler tasks, and increases in negative mood ratings immediately after working on the tasks.

Performance on Simple Mental Tasks

In Experiment 2, subjects worked for a total of 24 minutes on an addition task, number comparison task and a finding A's task, while exposed to the stressor. The quality of performance on each of these tasks for both groups is presented in Table 9. As predicted, there were virtually no differences between the groups on total number of items completed or on mean number of errors. A marginal effect (t = 1.81, p = .08) was found for errors on the number comparison task. Subjects in the noise group had more errors than the no noise control group. In general, however, quality of performance on these simple mental tasks was not impaired by exposure to the noise. Similar results have been obtained by other researchers using this paradigm (e.g. Glass & Singer, 1970; Cohen, 1980; Cohen et al., 1986).

Coping Strategies Employed

Group differences for total number and type of coping strategies is presented in Table 10. After working on the "filler tasks," subjects in the noise group used significantly more coping strategies in general,

(t = 2.98, $p < .01$). This increase was due to emotion-focused strategies, (t = 3.42, $p < .001$); no group differences were found for problem-focused strategies. In addition, it was found that the greater the number of emotion-focused coping strategies used in dealing with completing the filler tasks, the greater use of heuristics (r = .34, p = .06) on the subsequent decision-making task.

Coping strategies were also found to correlate significantly with self-reports of mood. Specifically, the higher the ratings of anxiety and hostility after the task, the greater use of coping strategies. This relationship was found to be true across experimental conditions, for total number of coping strategies (r = .39, p = .03 for anxiety; r = .50, p = .004 for hostility), for problem-focused strategies (r = .32, p = .07 for anxiety; r = .44, p = .01 for hostility) and for emotion-focused coping strategies (r = .32, p = .07 for anxiety; r = .41, p = .02 for hostility). While not significant, a reversed trend was found for emotion-focused coping and mood reportings at the end of the experiments. Namely, the more emotion-focused coping strategies employed, the less anxious and less hostile were subjects at the end of the experiment. In examining these correlations by condition, significant correlations were only found between hostility and all types of coping for subjects in the noise condition. Specifically, the higher the rating of hostility after the task, the greater use of total number of coping strategies (r = .60, p = < .01), problem-focused strategies (r = .55, $p < .02$), and emotion-focused coping (r = .48, p = .06).

Cognitive Aftereffects

The same decision-making instrument used in Experiment 1 was used in Experiment 2. However, to assess aftereffects of the stressor, subjects

in Experiment 2 completed this task in part II of the experiment, after the noise was terminated. t-tests conducted to examine differences on individual items revealed a trend of more subjects in the noise group, relative to the control group, using heuristics on 16 of the 26 heuristics. Significant differences were found for Item 3 (t = 2.67, p = .01) and Item 25 (t = 2.30, p = .03). A marginal effect for noise was also found on Item 18 (t = 1.81, p = .08). Items 18 and 25 are two of the items from the risk-aversion scale. Group differences on the risk-aversion and risk-seeking scales are reported separately. Frequency of use of heuristics across subjects for the two conditions is provided in Figure 5. As can be seen, out of a total of 26 heuristics, subjects in the noise group used an average of 18 heuristics, ranging from a low of 12 to a high of 23 in their use of heuristics. In the control group, the mean was 15 with a range from 12 to 19. As predicted, the group that had been exposed to the noise used significantly more heuristics across all items (t = 1.98, p = .05) than the control group. Noise subjects used heuristics on 69 percent of all items while the control group used heuristics on 58 percent of all items.

In examining the risk-aversion and risk-seeking scales for experimental group and sex effects in a 2 x 2 analysis, females were found to be significantly more risk-averse than males, $F(1,28) = 5.4$, $p < .05$. An effect for experimental condition in the predicted direction, but not reaching significance, was also found. The stressed group was more risk-averse than the control group, $F(1,28) = 2.27$, $p = .14$. The stressed group reported being risk-averse on three of the four items, while the control group was risk-averse on two of the four items. Differences were also found between the groups when examining correlations

between risk-aversion and risk-seeking. For the stressed group, risk-aversion correlated positively with risk-seeking ($r = .52$, $p = .04$) suggesting that subjects in the stressed group were influenced by the formulation of the problem. In comparison, for the nonstressed group, risk-aversion did not correlate with risk-seeking ($r = -.043$, $p = .87$).

For subjects in the stressed condition, an interesting pattern was found, between the use of heuristics and self-reported mood ratings at the end of the experiment. Specifically, for the greater the number of heuristics used, the less anxious ($\underline{r} = -.52$, $\underline{p} = .03$), the less depressed ($\underline{r} = -.34$, $\underline{p} = .20$) and the less hostile ($\underline{r} = -.48$, $\underline{p} = .06$) were subjects at the conclusion of the experiment.

Confidence Ratings

Mean confidence ratings given for all 12 items was 2.9 out of 5 for the noise group and 2.6 for the control group. Subjects who had been exposed to noise were more confident in their responses than those in the control group ($\underline{t} = 2.30$, $\underline{p} = .03$). The finding suggests that the aftereffects of noise included not only greater use of heuristics, but greater confidence in the responses.

In order to determine whether the use of heuristics was related to greater confidence, two way analyses of variance between condition and use of heuristics were conducted on items having a fairly even distribution of heuristic use. Items 1, 4, 5, 14, and 24 met this requirement. As can be seen from Table 11, subjects who had been exposed to the noise showed significantly greater confidence on their answers for Items 1, 4, and 24. Both heuristic users and non-heuristic users reported comparable confidence ratings.

Chapter 5

Discussion

Use of Heuristics in the Normative Sample

The present research was designed to shed light on the relationship between stress and decision making. Specifically, the effects of an unpredictable and uncontrollable stressor on the use of heuristics, or short cutting strategies in making judgments of probability, were examined. In order to determine the use of heuristics in a sample comparable to the study sample, a decision-making instrument, consisting of 26 items covering four different heuristics, was administered to 100 undergraduates. As Tversky and Kahneman found, the majority of respondents employed a heuristic in answering the majority of questions. While this data replicates the previous research concerning the existence of heuristics, there were two additional findings that warrant further investigation. Contrary to what would have been expected, items tapping both the availability and representativeness heuristics were not internally consistent. In other words, their conceptual relatedness did not hold up under statistical investigations. Secondly, in the normative sample, while items tapping both risk-aversion and risk-seeking were internally consistent, risk-aversion was significantly correlated, but negatively, with risk-seeking. From the literature, one would have expected the two subscales to correlate positively since the same individual is supposed to be risk-averse in decisions that involve opportunity for gain and risk-seeking in decisions that involve risk of loss.

The present results suggest that changes in the formulation of the decision problem do not always reverse an individual's preference from risk-aversion to risk-seeking or vice versa. Previous studies that

have found this reversal in preferences, have used two separate samples when reporting the results. In addition, previous studies have not examined an individual's consistent use of heuristics across a variety of decisions. The lack of internal consistency found in the present study, across all items as well as items tapping both the availability and representative heuristic, suggest that heuristic use is not trait-like, i.e., it is not an individual difference variable. The internal consistency found for the risk-aversion and risk-seeking scales may be inflated due to the highly similar wording of the questions comprising these two scales.

While such measurement artifacts described above may have led to differences found between the present and original research, the lack of correlations among heuristics also suggests that heuristics may be serving several purposes. Heuristics might be employed only under conditions of duress to reduce cognitive load. Heuristics may be used as coping strategies to reduce an individual's uncertainty, either about the task at hand or the conditions in which the person must cope. Heuristics may also be an effect of adjusting to stressful situations. For example, while it was found that subjects in the normative sample were either consistently risk-averse or risk-seeking regardless of the formulation of the problem, the expected reversal in preference was found only for subjects in Experiment 2 who had been exposed to a stressor. Stressed subjects relied more heavily on the information "at hand." All of these explanations suggest the importance of exploring the context in which heuristics are used to explain reasons for their use.

Effects of Stress on Decision-Making During Exposure to the Stressor

The second part of the study used the decision making instrument, on which normative data was collected, to examine one context which might alter the use of heuristics. The research examined whether stress alters an individual's decision making process and reported confidence in the decision that is reached.

From results of the first experiment, it appears that stress did not affect the decision-making process. Subjects used a comparable number of heuristics regardless of whether they were exposed to a stressor or not. While the results do not confirm the hypothesis that stressed subjects would make greater use of heuristics than the control group, the findings are consistent with other research showing no cognitive impairment during exposure to an acute stressor (Hockey, 1970; Glass & Singer, 1972; Cohen, 1980). In the present study, the demands of the decision-making task, in conjunction with psychological stress (characterized by the unpredictability and uncontrollability of the noise), were within the individual's total information-handling capacity. Previous studies have shown that unpredictable noise has impaired performance only on a subsidiary task while the individual has maintained a constant level of primary task performance (e.g., Finkelman and Glass, 1970).

While stress did not affect cognitive performance, there was a tendency for it to increase a person's confidence in his/her decisons. Stress may be acting to decrease a decision maker's ability to generate plausible solution alternatives and to assess accurately what is known or to seek additional information. These strategies have been reported to be typical ways in which a person reduces the complexity of the decision process (Seiber, 1974, Keinan, 1987). Lichtenstein and Fischhoff

(1977) have suggested that overconfidence may be a result of an insensitivity to the tenuousness of the assumptions on which judgments are based. Overconfidence may be related to denial of uncertainty since uncertainty is anxiety arousing and stressful in and of itself. In this experiment, the quality of the decision was not related to expressed amount of confidence. Future studies need to examine and differentiate mechanisms by which stress increases a person's confidence in decisions.

As in previous studies examining aftereffects, exposure to the stressor did result in significant behavioral aftereffects. However, these results were found for males only. Namely, men in the stressed group persisted significantly less on the insolvable puzzle than men in the control group. Women, on the other hand, persisted regardless of whether they were exposed to the stress or not. During the debriefing when women were asked why they had persisted, women in both groups indicated that they had wanted to compensate for what they believed to be poor performance on the decision making instrument. Others indicated that persistence was a personality trait. While many studies have not reported sex differences, the findings may reflect sex differences in physiological arousal to the acute stressor. In the present study, women's heart rate and blood pressure during the task remained either the same or within two points of baseline measures. Males showed increases of four and five points on diastolic pressure and heart rate measures, respectively, while performing the task. It is possible that women handled the stress more "efficiently" and thus were not as fatigued as men after termination of the stressor.

Similar sex differences in physiological arousal have been reported by Frankenhaueser (1975) and most recently by Stoney, Davis and

Matthews, (1987). Studies reported by Frankenhaeuser (1975) showed that epinephrine excretion was about the same for women performing an intelligence test under time pressure as during daily routine activity. In contrast, male subjects increased their epinephrine output significantly when required to complete the intelligence test. A meta-analysis of all psychophysiological studies published in English language journals between 1965 and 1986 found not only that males exhibited significantly larger urinary epinephrine responses during an acute stressor, but also that males in comparison to females exhibited significantly higher systolic blood pressure at rest and during challenge to acute behavioral stressors (Stoney, Davis & Matthews, 1987).

Effects of Stress on Decision-Making After Stressor Was Terminated

The results of the second study extend previous research on aftereffects that have shown deficits in persistence and concentration (e.g. Glass & Singer, 1972; Cohen, 1980). As previous studies have shown, stress did not impair performance on simple numerical and verbal tasks that were administered during the stressor. However, aftereffects of the stressor included increases in the use of heuristics or short-cutting strategies as well as greater confidence in decisions that were made. While confidence in decisions was significantly greater for those who had been exposed to a stressor, as in experiment one, confidence was not associated with quality of performance. Since the mean difference in confidence level between the stressed and non-stressed groups in both experiments was minimal, future studies need to replicate this result before great significance is attached to this finding.

In addition to uncovering these main effects, interesting correlations were found between the use of coping strategies, use of

heuristics and mood data. Subjects working on the verbal and numerical tasks under stress used significantly more coping strategies than the control group subjects, the increase being due to more emotion-focused strategies. In addition, the higher the ratings of anxiety and hostility, the greater use of coping strategies. Emotion-focused strategies also correlated with greater use of heuristics on the subsequent decision-making task. Finally, both greater use of heuristics and emotion-focused coping were correlated with lower levels of anxiety and hostility at the end of the experimental session. No other previous studies have asked subjects to identify the strategies they have used in coping with a stressor. While more studies need to tap this measure, at least one interpretation of the data could be that emotion-focused strategies have a tendency to make a person feel better regardless of one's efforts at maintaining task performance. The associations found between emotion-focused strategies, increased use of heuristics, and better moods may suggest that employing a shortcutting strategy is an attempt or effort at maintaining a better feeling about one's self rather than a voluntary effort at maintaining cognitive performance. Another interpretation of the data could be that emotion-focused subjects were more vulnerable or prone to use heuristics. A mechanism for this relationship is described below.

Mechanisms Explaining Aftereffects

To reiterate, the main purpose of this study was to determine whether a relationship existed between stress and decision-making. Experiment two shows quite conclusively that aftereffects of stress include both increases in use of shortcutting strategies and increased confidence in the decisions that are made. The mechanism by which stress

exerts these aftereffects needs to be explored further. Both Glass and Singer's (1972) adaptive cost hypothesis and Cohen's (1980) overload hypothesis could explain the results. According to the adaptive-cost hypothesis, while human beings are highly adaptable and capable of adjusting to stressful environments, the adjustments or increased coping as has been demonstrated in this study, may have aftereffects. The adaptive efforts may leave the person less able to cope with subsequent demands and less resistent to later frustrations. Cohen's overload hypothesis suggests that it is the informational demands on mental capacity created by continuously coping with trying to monitor the unpredictable stressor as well as complete the task that leads to cognitive fatigue and aftereffects. Reserves are depleted and there is insufficient capacity to perform subsequent tasks. Once an individual is overloaded, for a time following such an experience, he/she may become overloaded at a lower threshold causing lower frustration tolerance and narrowing of attention to the most dominant responses.

Cohen's overload hypothesis for explaining aftereffects is, in fact, a form of the adaptive-cost hypothesis. The overload hypothesis, in effect, describes a mechanism whereby the process of coping with stress causes aftereffects. Specifically, it is thought that the cognitive fatigue that results from the heightened coping efforts, is responsible for aftereffects. Another mechanism that has been used to explain aftereffects is the persistent use of coping strategies even after the stressor is terminated. While a particular strategy may be helpful during exposure to a stressor, it may not prove to be adaptive once an individual is removed from that environment.

In both experiments of the present research, subjects exposed to the unpredictable and uncontrollable stressor used more emotion-focused coping strategies than the control subjects. This finding is consistent with other research that has shown that it is adaptive for individuals to use more emotion-focused coping when there is little one can do to directly alter the situation (Collins, Baum, & Singer, 1983). However, persistence of emotion-focused coping, even after the stressor was terminated, might have led to insufficient problem-solving coping mechanisms, resulting in perhaps, decreased ability or desire to generate ways of solving the insolvable puzzle on the frustration-tolerance task in Experiment One, and increased use of shortcutting strategies in Experiment Two. Direct assessment of the subject's use of emotion- and problem-focused strategies during the poststimulation task could help to determine the validity of this mechanism for explaining aftereffects.

Extensions and Applications of Present Research

An interesting extension of this research would be to examine a chronically stressed population for evidence of distinctions in their decision-making processes as well as coping strategies. After prolonged exposure to stress, is the increased use of shortcutting strategies one of the shifts in information processing that occurs? In addition, is there evidence for overlearning of a particular coping strategy?

In conclusion, the present study has raised some new questions concerning a person's use of heuristics that are not consistent with the theoretical underpinnings on which heuristic research is based. Furthermore, the study has extended aftereffects of stressors to include alterations in decision-making and confidence. In addition to providing new avenues of research, the study also has practical implications for

decision making. A key element in decision making is the ability to interpret and integrate various pieces of information. This ability seems to be impaired after one is exposed to stressful situations. More reliance is put on specific information immediately available while neglecting what we knew before receiving evidence specific to the case at hand. While heuristics may help to decrease one's anxiety, they may also lead to less creative solutions. Decision makers need to be made aware of how the decision-making process can be altered by stress and seek ways in which information can be integrated rather than simply serially processed.

Chapter 6

Summary

While many of today's judgments and decisions are frequently made under conditions of duress, empirical evidence is lacking for the effects that environmental stressors have on decision-making. The present research sought to integrate findings from research in the areas of stress and decision-making to determine the effects that stress has on decision-making. Researchers examining the process by which individuals make decisions have found that when faced with problems of judging probabilities, making predictions, and more generally, coping with uncertainty, the individual uses judgmental heuristics which serve as general strategies or rules of thumb for simplifying complex tasks (Kahneman et. al., 1982).

While these heuristics can produce correct inferences, individuals often misuse these heuristics. A number of different types of heuristics have been identified. Specifically, when using the "availability" heuristic, the individual will judge an event as likely or frequent if instances of it are easy to imagine or recall without realizing that recall, but not frequency of the event, can be affected by personal experiences with the event in question. In applying the "representative" heuristic, probabilities are evaluated by the degree to which features of the target are compared to features of possible outcomes, and the outcome that is more representative of the target is chosen. This heuristic strategy is insensitive to sample size, base rates, reliability of the evidence, and expected accuracy of the prediction.

Whether or not an individual makes a "risk-averse" or risk-seeking" decision may very well depend on the formulation of the decision problem. Individuals will be risk-averse on decisions that involve opportunity for gain and risk-seeking on decisions that involve risk of loss. Finally, individuals have been shown to undervalue outcomes that are merely probable to those outcomes that are obtained with certainty. Research in this area has also found that individuals are typically overconfident about the judgments that are based on these heuristics. These findings have generalized across different samples of subjects, across tasks involving predictions, probabilities and uncertainty, both in the lab and in the field.

Research examining the effects of stress on cognitive performance has focused primarily on the effects of noise on two aspects of skilled performance, namely attention and memory (Cohen, et. al., 1986). While the emphasis has been on task proficiency and efficiency, investigators have identified strategies that individuals use to adapt to the stressor. These include a shift in attention toward the most dominant cues in a task, and a reduction in the use of intermediate categories of confidence. Research in this area has also found that stress may exert its effects only after the stressor is terminated (Glass & Singer, 1972).

The present research integrated the two areas of stress and decision-making by employing an acute, unpredictable and uncontrollable noise stressor and noting its effects on the use of heuristics, or shortcutting strategies for making decisions. In order to determine the use of heuristics in a sample comparable to the study sample, a decision-making instrument covering the four different heuristics, known as

availability, representativeness, certainty, and risk taking was administered to 100 undergraduates. The present results replicated previous research that has shown that the majority of respondents employ a heuristic in making decisions. However, items tapping neither the availability nor representative heuristics correlated sufficiently to represent two different heuristic "scales." Items tapping the risk taking heuristic did produce two scales, namely a risk-averse scale and a risk-taking scale. Overall, low reliability coefficients between the heuristics suggested that people are not consistent in their use of heuristics, using them at some times, but not others. The findings furthermore suggest the importance of exploring the context in which heuristics are used to explain reasons for their use.

The second part of the study used the decision-making instrument, on which normative data was collected, to examine one context which might alter the use of heuristics. The research examined whether stress altered an individual's use of heuristics and reported confidence in the decision that was reached. Two experiments were conducted in parallel fashion. The first experiment was designed to examine the effects of an environmental stressor on decisions made during exposure to that stressor. Thirty-two subjects, recruited from local universities, completed the decison-making instrument either under quiet conditions or while being exposed to intermittent noise bursts of 105dB(A) that were delivered free-field through a speaker system. After completing the decision-making instrument, all subjects then attempted to solve an insolvable puzzle while working under quiet conditions. The results indicated that stress did not affect the decision-making process. Subjects used a comparable number of heuristics regardless of whether

they were exposed to a stressor or not. While stress did not affect cognitive performance, there was a tendency for it to increase a person's confidence in his/her decisions. In addition, consistent with other research examining aftereffects of stress, males exposed to the stressor showed significantly less tolerance for frustration in solving the insolvable puzzle, then males in the control group. Females persisted regardless of whether they were exposed to the stressor or not.

The second experiment was designed to examine the effects of an environmental stressor on decisions made after the stressor was terminated. In this experiment, thirty-two subjects completed simple numerical and verbal tasks either under quiet conditions or while being exposed to the same noise stressor used in the first experiment. After completing these tasks, all subjects then completed the decision-making instrument under quiet conditions. The results of the second experiment demonstrated that stress did not impair performance on the simple tasks, but did result in poststimulation effects. The effects included both increases in the use of heuristics and increased confidence in the decisions that were made by those subjects who had prior exposure to the noise.

A number of mechanisms have been advanced to explain how stress exerts these aftereffects. Both the adaptive cost hypothesis (Glass & Singer, 1972) and the cognitive overload hypothesis (Cohen, 1980) could explain the results. According to the adaptive-cost hypothesis, while subjects demonstrated through their performance that they were capable of adjusting to the stressful environment, the increased coping or adjustments that were made to adapt to the suboptimal environment may have left the person less able to cope with subsequent demands and less

resistant to later frustrations. The overload hypothesis suggests that it is the informational demands on mental capacity, created by continuously coping with trying to monitor the unpredictable stressor, as well as complete the tasks, that leads to cognitive fatigue and aftereffects. Perhaps once the subjects who performed under stress became overloaded, they became overloaded at a lower threshold following exposure to the stressor, causing lower tolerance for frustration and narrowing of attention to the most dominant responses.

Another mechanism that has been used to explain aftereffects is the persistent use of coping strategies even after the stressor is terminated. In both experiments of the present research, subjects exposed to the unpredictable and uncontrollable stressor used more "emotion-focused" coping strategies, strategies that served to regulate or manage individuals' emotional responses to the situation. While it may have been adaptive for subjects who were exposed to the stressor to use more emotion-focused coping strategies when there was little one could do to directly alter the situation, persistence of emotion-focused coping, even after the stressor was terminated, might have led to insufficient problem-solving coping strategies. Overconcentration on emotion-focused strategies could have resulted in, perhaps, decreased ability or desire to generate ways of solving the insolvable puzzle on the frustration tolerance task, and increased use of shortcutting strategies on the decision-making instrument.

Future research in the area of stress and decision-making needs to assess the types of coping strategies that individuals employ both while they are exposed to the stressor as well as during the post-stimulation tasks. In addition, future research needs to examine the

mechanisms by which stress increases a person's confidence in his/her decisions.

The present results also have practical implications for decision-making. The results suggest that the ability to interpret and integrate various pieces of information seem to be impaired after one is exposed to a stressful situation. More reliance is put on specific information immediately available while neglecting what was known before receiving evidence specific to the case at hand. Decision makers need to be made aware of how the decision-making process can be altered by stress and seek ways in which information is integrated rather than simply serially processed.

Table 1

Percent of Respondents Using Heuristics by Category for Present Study and Original Studies

	Percent Using Heuristic	
Availability Heuristic	(Tversky & Kahneman, 1973) Results	Present Results (N = 100)
1. (Item 1) Consider the letter K. The letter appears as the first letter as well as an internal letter in words. Consider words of more than 3 letters. Is K more likely to appear in _____ the first position (1) _____ the third position (0)	Percentages not reported for individual letters. 69% (N = 152) judged the first position to be more likely for a majority of the letters. Those letters included K,L,N,R, and V.	58%
2. (Item 3) Consider the letter L . . . _____ first position (1) _____ third position (0)		51%
3. (Item 5) Consider the letter R . . . _____ first position (1) _____ third position (0)		54%
4. (Item 7) Which of the structures below, A or B, are there more paths _____ path A (1) _____ path B (0)	85% (N = 54)	77%
5. (Item 10) What is the number of different patterns of 3 stops vs 7 stops that a bus can make? 3 stops _____ (1) 7 stops _____ (0)	Percentages not reported	53%
6. (Item 14) Consider a group of 10 people who have to form committees of "r" members. How many different committees of "r" members can they form where r = 2 _____ (1) r = 8 _____ (0)	Percentages not reported	52%

Availability Heuristic	Percent Using Heuristic: (Tversky & Kahneman, 1973) Results	Present Results (N = 100)
7 - 11. (Items 20-24) Which of the two causes of death is more likely in general in the United States		
Item 20 - accidental falls (1)	Percentages	
emphysema (0)	not reported	69%
Item 21 - suicide (0)		
homicide (1)		67%
Item 22 - all accidents (1)		
stomach cancer (0)		89%
Item 23 - stomach cancer (0)		
breast cancer (1)		61%
Item 24 - accidents caused by fire (1)		
diabetes (0)		57%

Representative Heuristic	(Kahneman & Tversky, 1972) Results	
1. (Item 4)		
A medical survey . . .		
Team checking 3 _____ (0)		
Team checking 1 _____ (0)	48%	
About the same _____ (1)	(N = 48)	50%
2. (Item 8)		
All families of six children . . .		
What is your estimate of number of families surveyed in which exact order of births	Percentages	
was BBBGGG < 72 (1)	not reported	67%
3. (Item 12)		
There are 2 types of aerobic programs . . .		
Class belongs to program A _____ (1)	75%	83%
Class belongs to program B _____ (0)	(N = 89)	
4. (Item 15)		
On each round of a game 20 marbles are distributed at random among five children . . .		
In many rounds of the game, will there be more results of		
Type I _____ (1)	69%	50%
Type II _____ (0)	(N = 52)	

	Percent Using Heuristic	
Representative Heuristic		Present Results (N = 100)
5. (Item 17) A certain town is served by two hospitals . . . Larger hospital _____ (0) Smaller hospital _____ (0) About the same _____ (1)	56% (N = 50)	47%
6. (Item 19) Two covered urns . . . 10 beads _____ (1) 100 beads _____ (0)	65% (N = 110) (Bar-Hillel, 1982)	52%

Risk Aversion (RA)	(Tversky & Kahneman, 1981) Results	Present Results
1. (Item 6) Choose between: A. a sure gain of $240 _____ (1) B. 25% chance to gain $1,000 and 75% chance to gain nothing _____ (0)	84%	61%
2. (Item 9) US is preparing for outbreak . . . Program A _____ (1) Program B _____ (0)	72% (N = 152)	65%
3. (Item 18) Choose between: A. a sure gain of $240 _____ (1) B. 35% chance to gain $1,000 and 65% chance to gain nothing _____ (0)		54%
4. (Item 25) Choose between: A. a sure gain of $240 _____ (1) B. 30% chance to gain $1,000 and 70% chance to gain nothing _____ (0)		63%

	Percent Using Heuristic	
	(Tversky & Kahneman, 1981) Results	Present Results (N = 100)
Risk Seeking (RS)		
1. (Item 2) Choose between: A. a sure loss of $750 _____ (0) B. 80% chance to lose $1,000 and 20% chance to lose nothing _____ (1)		71%
2. (Item 13) Choose between A. a sure loss of $750 _____ (0) B. 75% chance to lose $1,000 and 25% chance to lose nothing _____ (1)	87%	77%
3. (Item 16) Imagine . . . Program C _____ (0) Program D _____ (1)	78% (N = 155)	70%
4. (Item 26) Choose between: A. a sure loss of $750 _____ (0) B. 85% chance to lose $1,000 and 15% chance to lose nothing _____ (1)		63%
Certainty (CY)		
1. (Item 11) A. A disease is expected to afflict 20% of the population. How likely would you be to volunteer to receive a vaccine that protects half of the people receiving it vs B. There are two mutually exclusive and equally probable strains of disease, each likely to afflict 20% of the population. How likely would you be to volunteer to receive a vaccine that gives complete protection against one strain and no protection against the other. If B > A scored as (1).	57% (N = 211) Slovic, Fischhoff & Lichtenstein (1982)	27%

Table 2

Reliability Statistics for the Decision-Making Instrument

Category	KR-20 Reliability Coefficients	
	All items	After dropping poorly discriminating items
Availability Heuristic	.22	.31
Representativeness Heuristic	.23	.29
Risk Aversion	.68	.49
Risk Seeking	.65	
Total Instrument	.18	.28

Reference: Cronbach, L. J. Coefficient alpha and the internal structure of tests. Psychometrika, 1951, 16, 297-334.

Table 3

Mean Ratings of the Environmental Conditions
on the Post Experimental Questionnaire (Experiment One)

	Experimental Condition		
	NOISE GROUP (N = 16)	NO NOISE (CONTROL) (N = 16)	
Irritating	5.7[a]	2.4	$t = 8.94$, $p < .001$
Unpleasant	5.9[a]	2.9	$t = 7.36$, $p < .001$
Distracting	5.4[a]	2.4	$t = 8.35$, $p < .001$
Task Difficulty	2.7[b]	3.5	$t = -2.09$, $p < .05$

[a] A high score means the noise was rated as more aversive

[b] A high score means the task was rated as easier

Table 4

Mean Ratings of Self-Reported Mood for Noise and Control Groups Over Time (Experiment One)

	ANXIETY		DEPRESSION		HOSTILITY	
TIME	NOISE	NO NOISE	NOISE	NO NOISE	NOISE	NO NOISE
Pre-manipulation	8.7	6.1	14.2	12.7	7.6	6.4
After task	10.2	7.1	17.7	15.4	10.9	8.4
End of Session	8.7	7.1	16.0	14.2	9.7	8.5
Mean	9.3	6.8	16.0	14.1	9.4	7.8
Effect for Condition:	$F(1,28)=10.79$, $p < .01$		$F(1,28)=2.22$, $p=.15$		$F(1,28)=4.04$, $p=.05$	

Note: Larger means indicate higher scores on the attribute listed. The total possible scores for anxiety, depression and hostility are 21, 29, and 28, respectively.

Table 5

Differences in Mean Number of Coping Strategies Employed by Noise vs Control Group (Experiment One)

CONDITION	COPING STRATEGY		
	TOTAL NO.	PROBLEM-FOCUSED	EMOTION-FOCUSED
Noise	12.5	5.6	6.1
No Noise	9.1	5.7	3.1
	$t = 1.61$ $p = .12$	$t = 0.13$ $p = .90$	$t = 2.28$ $p = .03$

Table 6

Mean Number of Attempts on the Insolvable Puzzle

SEX	CONDITION		
	NOISE	NO NOISE	MEAN
Male	9.7	16.1	12.7
Female	21.3	16.3	18.8
Mean	15.6	16.2	

Effect for Sex, $F(1,27) = 4.12$, $p = .05$

Condition x Sex interaction, $F(1,27) = 3.7$, $p = .06$

Table 7

Mean Ratings of the Environmental Conditions
on the Post Experimental Questionnaire (Experiment Two)

ITEM	EXPERIMENTAL CONDITIONS: NOISE (N = 16)	NO NOISE (CONTROL) (N = 16)	
Irritating	5.9[a]	2.6	$t = 7.43$, $p < .001$
Unpleasant	6.3[a]	2.9	$t = 9.54$, $p < .001$
Distracting	4.9[a]	2.1	$t = 6.74$, $p < .001$
Task Difficulty	5.3[b]	5.8	$t = 1.02$, $p = .31$

[a] A high score means the noise was rated as more aversive

[b] A high score means the task was rated as easier

Table 8

Mean Ratings of Self-Reported Mood for Noise and Control Groups Over Time (Experiment Two)

	ANXIETY		DEPRESSION		HOSTILITY	
TIME	NOISE	NO NOISE	NOISE	NO NOISE	NOISE	NO NOISE
Pre-manipulation	9.4	8.4	13.1	12.5	6.2	7.1
After task	10.2	9.5	16.0	17.1	11.2	10.5
End of Session	6.9	8.3	14.6	17.1	7.8	9.9
Mean	8.8	8.7	14.5	15.5	8.4	9.2
Effect for Time:	$F(2,60)=5.10$, $p < .01$		$F(2,60)=13.42$, $p < .001$		$F(2,60)=15.5$, $p < .001$	

Table 9

Mean Number of Items Completed and Mean Number of Errors for the Addition, Number Comparison and Finding A's Task

	TYPE OF TASK					
	ADDITION		NUMBER COMPARISON		FINDING A'S	
Condition	Completed	Errors	Completed	Errors	Completed	Errors
Noise	69.4	2.9	69.1	5.5	130.9	23.5
No Noise	73.7	4.0	64.8	2.7	126.8	25.1
	t=-0.72 p=.48	t=-1.06 p=.29	t=1.05 p=.30	t=1.81 p=.08	t=0.44 p=.66	t=-0.23 p=.82

Table 10

Differences in Coping Strategies Employed by Noise vs Control Group (Experiment Two)

CONDITION	COPING STRATEGY		
	TOTAL NO.	PROBLEM-FOCUSED	EMOTION-FOCUSED
Noise	12.7	4.9	7.5
No Noise	7.6	4.4	2.9
	$t = 2.98$ $p = .006$	$t = 0.61$ $p = .55$	$t = 3.42$ $p = .002$

Table 11

Mean Confidence Ratings on Selected Items (Experiment Two)

	ITEM 1		ITEM 4		ITEM 24	
	HEURISTIC USE		HEURISTIC USE		HEURISTIC USE	
Condition	Yes	No	Yes	No	Yes	No
Noise	4.5 (N=10)	4.5 (N=6)	3.50 (N=10)	3.3 (N=6)	1.63 (N=8)	1.13 (N=8)
No Noise	3.7 (N=7)	3.9 (N=9)	2.3 (N=7)	3.3 (N=9)	1.00 (N=8)	1.00 (N=8)
Effect for Condition:	$F(1,28)=6.57$, $p<.02$		$F(1,28)=3.33$, $p<.08$		$F(1,28)=4.67$, $p<.04$	

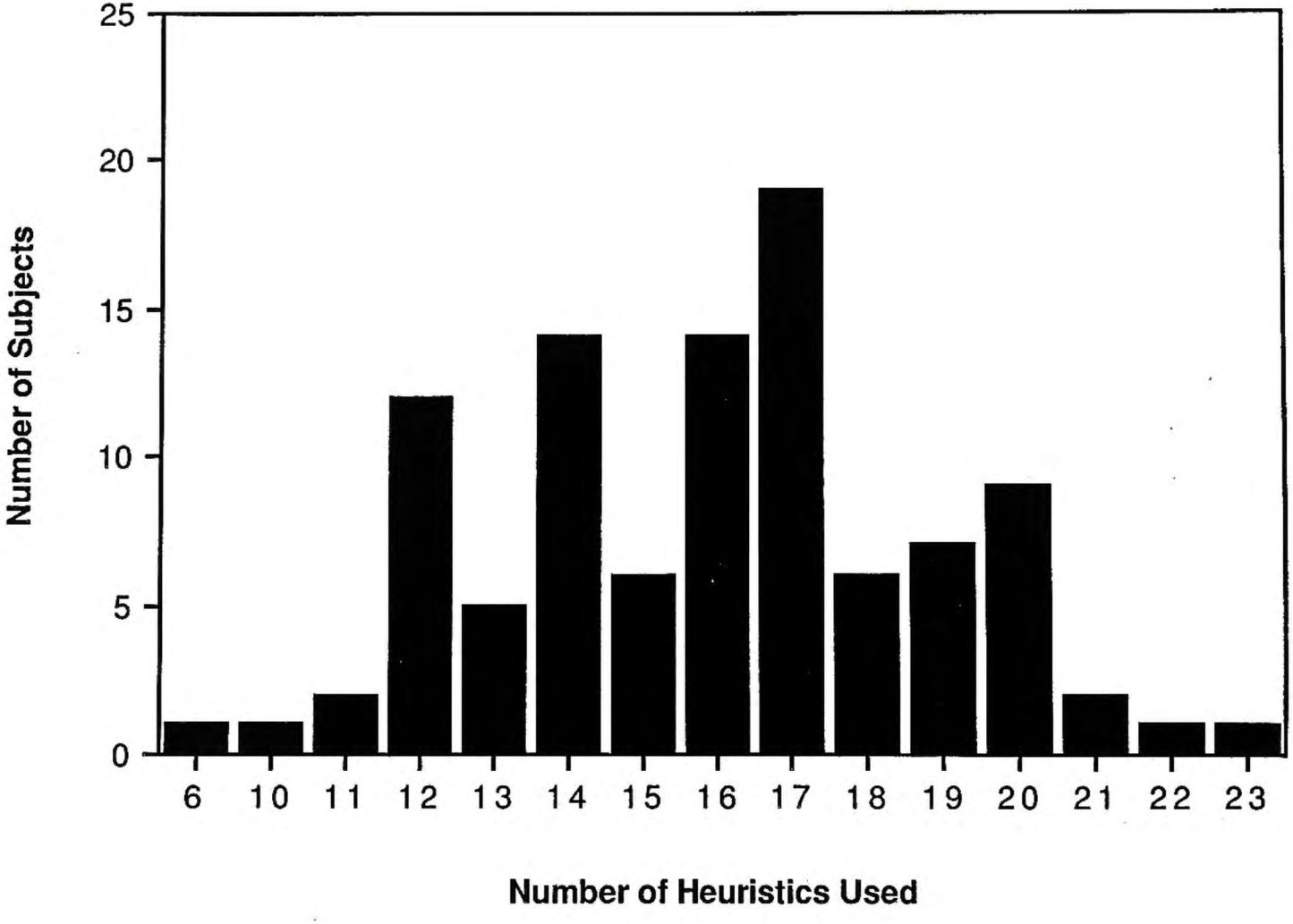
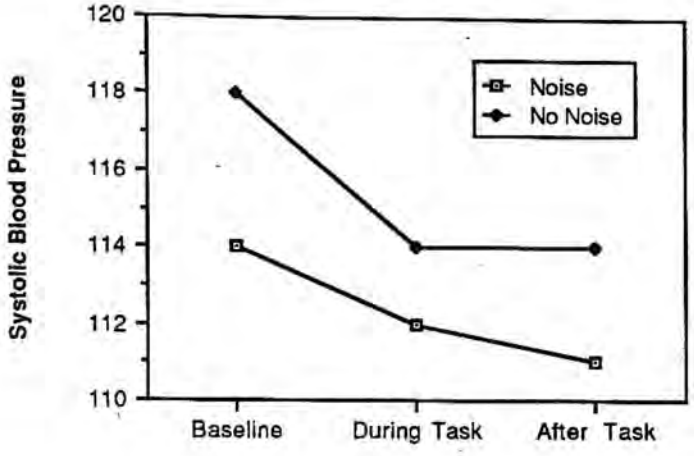
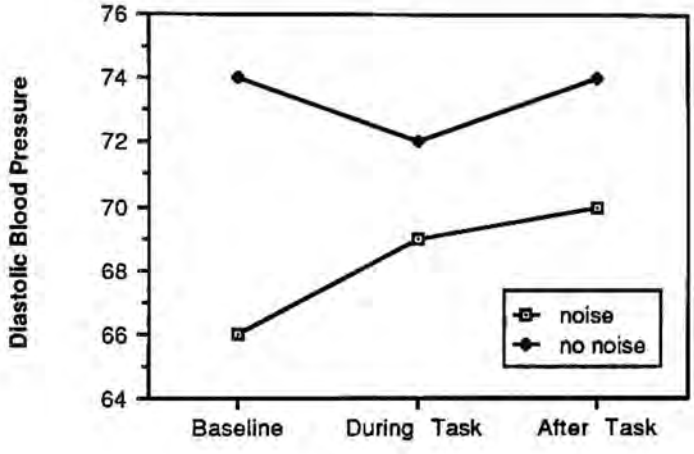


Figure 1. Frequency of Use of Heuristics in Normative Sample (N=100)





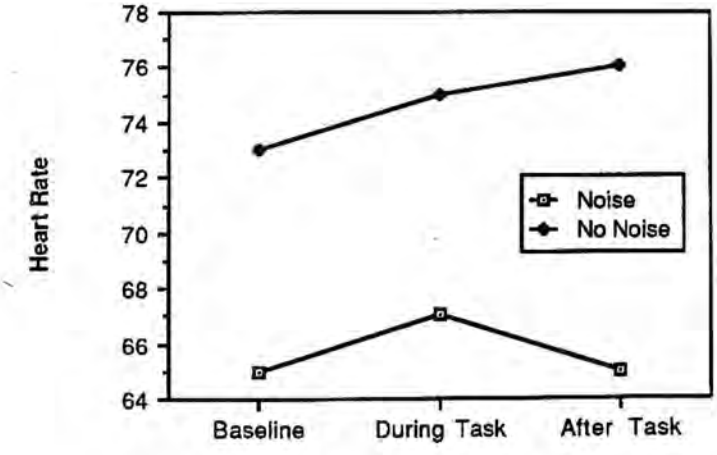


Figure 2. Physiological Data (Experiment One)

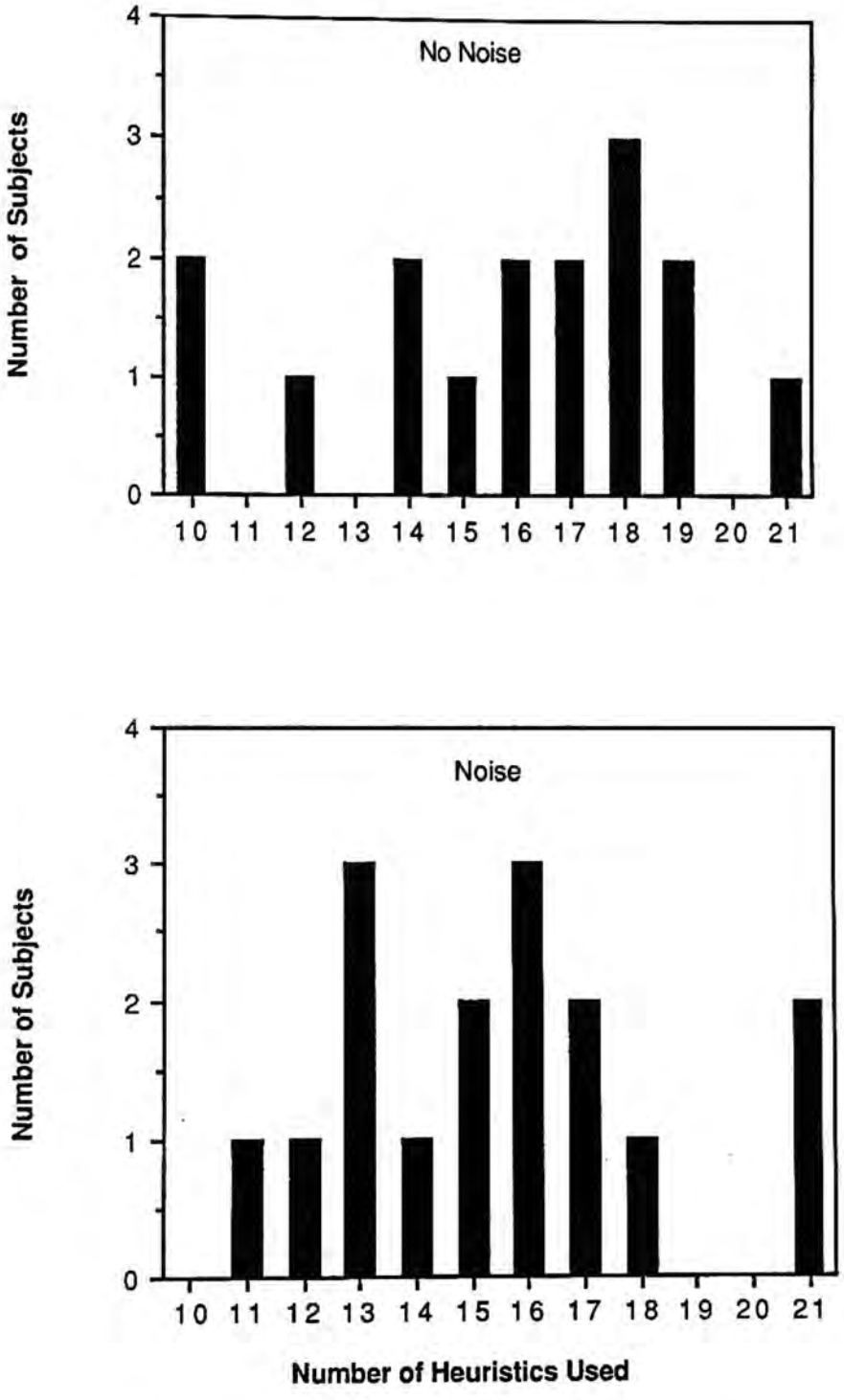
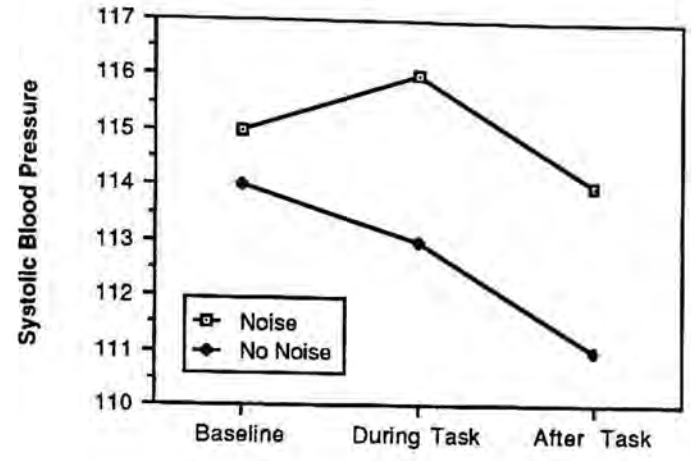
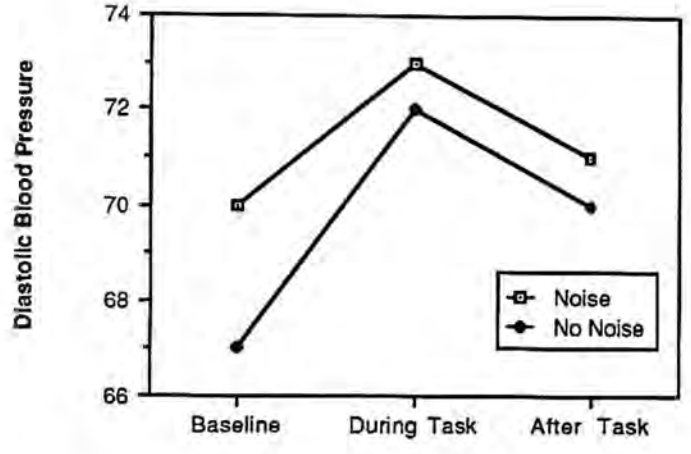


Figure 3. Frequency of Use of Heuristics in Noise vs. No Noise (Control) Group (Experiment One)





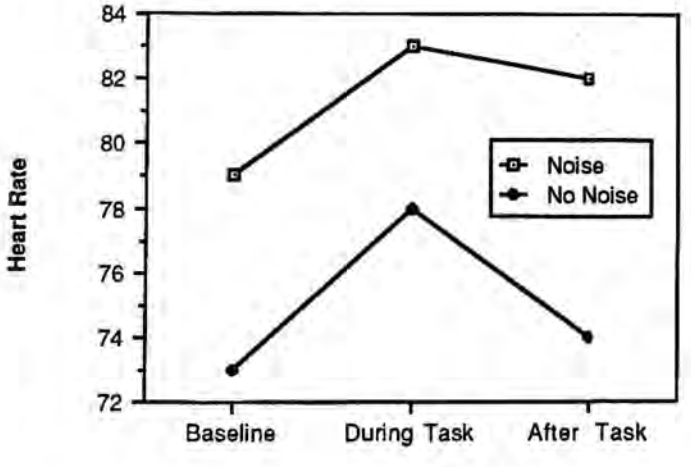


Figure 4. Physiological Data (Experiment Two)

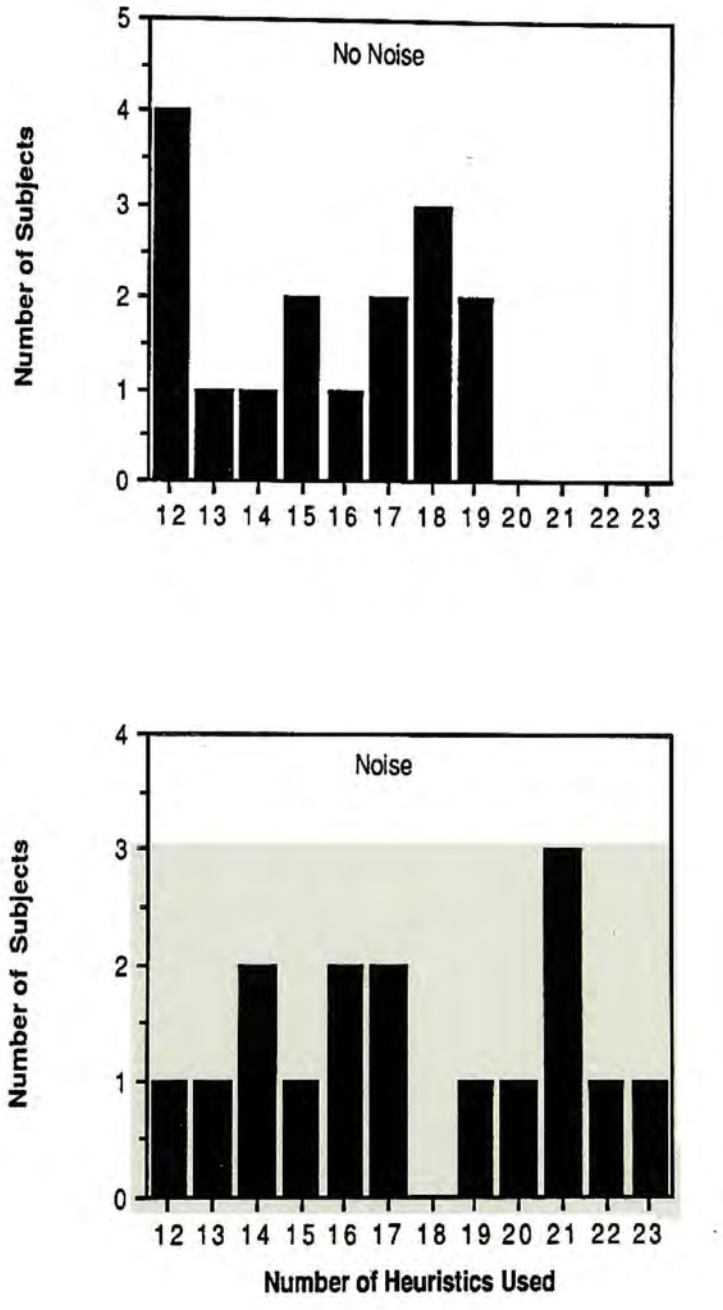


Figure 5. Frequency of Use of Heuristics in Noise vs. No Noise (Control) Group (Experiment Two)

APPENDIX A

Consider the letter K. The letter appears as the first letter as well as an internal letter in words. Consider words of more than three letters.

Is K more likely to appear in

_____ the first position?

_____ the third position?

My estimate for the ratio of these two values is _____:1.

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

Choose between:

A. a sure loss of $750

B. 80% chance to lose $1,000 and
20% chance to lose nothing

Consider the letter L. The letter appears as the first letter as well as an internal letter in words. Consider words of more than three letters.

Is L more likely to appear in

_____ the first position?

_____ the third position?

My estimate for the ratio of these two values is _____:1.

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

A medical survey is being held to study some factors pertaining to coronary diseases. Two teams are collecting data. One checks three men a day, and the other checks one man a day. These men are chosen randomly from the population. Each man's height is measured during the checkup. The average height of adult males is 5 ft. 10 in., and there are as many men whose height is above average as there are men whose height is below average.

The team checking three men a day ranks them with respect to their height, and counts the days on which the height of the middle man is more than 5 ft. 11 in. The other team merely counts the days on which the man they checked was taller than 5 ft. 11 in. Which team do you think counted more such days?

The team checking 3 _____

The team checking 1 _____

About the same (i.e., within 5% of each other) _____

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

Consider the letter R. The letter appears as the first letter as well as an internal letter in words. Consider words of more than three letters.

Is R more likely to appear in
_____ the first position?

_____ the third position?

My estimate for the ratio of these two values is _____:1.

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

Choose between:

A. a sure gain of $240

B. 25% chance to gain $1,000 and
75% chance to gain nothing

A path in a structure is a line that connects an element in the top row to an element in the bottom row, and passes through one and only one element in each row. For example, two paths are drawn in this structure provided below.

In which of the two structures below, A or B, are there more paths?

(A)

x x x x x x x x

x x x x x x x x

x x x x x x x x

(B)

x x

x x

x x

x x

x x

x x

x x

x x

x x

How many total paths do you think are in:

Structure A _____

Structure B _____

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

All families of six children in Washington, DC were surveyed. In 72 families, the exact order of births of boys (B) and girls (G) was GBGBBG.

What is your estimate of the number of families surveyed in which the exact order of births was BGBBBB? _____

What is your estimate of the number of families surveyed in which the exact order of births was BBBGGG? _____

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

If Program A is adopted, 200 people will be saved.

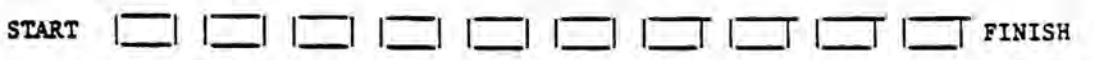
If Program B is adopted, there is a one-third probability that 600 people will be saved and a two-thirds probability that no people will be saved.

Which of the two programs would you favor?

Program A _____

Program B _____

In the drawing below, there are ten stations along a route between Start and Finish. Consider a bus that travels, stopping at exactly 3 stations along this route.



What is the number of different patterns of 3 stops that the bus can make?

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

A disease is expected to afflict 20% of the population. Would you volunteer to receive a vaccine that protects half of the people receiving it?

The liklihood of my getting vaccinated is (Circle one number).

1	2	3	4	5	6	7
Almost certainly would <u>not</u> get vaccinated						Almost certainly would get vaccinated

There are two types of aerobic programs in an adult education center. Men are a majority (65%) in program A, and a minority (45%) in program B. There is an equal number of aerobic classes in each of the two types of programs.

You enter a class at random, and observe that 55% of the students are men. What is your best guess?

The class belongs to program A _____

The class belongs to program B _____

Choose between:

A. a sure loss of $750

B. 75% chance to lose $1,000 and
25% chance to lose nothing

Consider a group of 10 people who have to form committees of "r" members where "r" is some number between 2 and 8. How many different committees of "r" members can they form . . .

When r = 2 _____

When r = 8 _____

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

On each round of a game, 20 marbles are distributed at random among five children: Alan, Ben, Carl, Dan and Ed. Consider the following distribution:

	I		II
Alan	4	Alan	4
Ben	4	Ben	4
Carl	5	Carl	4
Dan	4	Dan	4
Ed	3	Ed	4

In many rounds of the game, will there be more results of type I or type II?

Type I _____

Type II _____

Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

If Program C is adopted, 400 people will die.

If Program D is adopted, there is a two-thirds probability that 600 people will die and a one-third probability that no one will die.

Which of the two programs would you favor?

Program C _____

Program D _____

A certain town is served by two hospitals. In the larger hospital, about 45 babies are born ech day, and in the smaller about 15 babies are born each day. As you know, about 50% of all babies are boys. The exact percentage of baby boys, however, varies from day to day. Sometimes it may be higher than 50% and sometimes lower.

For a period of 1 year, each hospital recorded the days in which more than 60% of the babies born were boys. Which hospital do you think recorded more such days?

The larger hospital _____

The smaller hospital _____

About the same (that is, within 5% of each other) _____

Choose between:

A. a sure gain of $240

B. 35% chance to gain $1,000 and
65% chance to gain nothing

You are presented with two covered urns. Both of them contain a mixture of red and green beads. The number of beads is different in the two urns. The small one contains 10 beads, and the large one contains 100 beads. However, the percentage of red and green beads is the same in both urns. The sampling will proceed as follows: You draw a bead blindly from the urn, note its color, and replace it. You mix, draw blindly again, and note down the color again. This goes on to a total of 9 draws from the small urn, or 15 draws from the large urn. In which case do you think your chances for guessing the majority color are better?

Small urn containing 10 beads _____

Large urn containing 100 beads _____

Each item consists of two different possible causes of death. Which cause of death is more likely in general in the U.S., of the two causes of death given.

For each pair of possible causes of death, A and B, we want you to mark which cause you think is MORE LIKELY, in general, in the United States. In answering this question, consider all the people now living in the United States - children, adults, everyone.

Also, decide how confifent you are that you have, in fact, chosen the more frequent cause of death. Indicate your confidence by the odds that your answer is correct. Odds of 2:1 mean that you are twice as likely to be right than wrong. Odds of 1,000:1 mean that you are a thousand times more likely to be right than wrong. Odds of 1:1 mean that you are equally likely to be right than wrong. That is, your answer is a guess.

A	B	More Likely (A or B)	How Confident Are You*
Accidental falls	Emphysema	_____	_____
Suicide	Homicide	_____	_____
All accidents	Stomach cancer	_____	_____
Stomach cancer	Breast cancer	_____	_____
Accidents caused by fires	Diabetes	_____	_____

* The scale below may give you an idea of the kinds of numbers you might want to use. You don't have to use exactly these numbers. You could write 75:1 if you think that that is 75 times more likely that you are right than you are wrong or 1.2:1 if you think you are only 20% more likely that you are right than wrong.

1	1	1	1	1	1	1	etc.
1:1	10:1	100:1	1,000:1	10,000:1	100,000:1	1,000,000:1	

Choose between:

A. a sure gain of $240

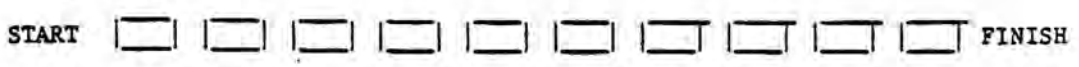
B. 30% chance to gain $1,000 and
70% chance to gain nothing

There are two mutually exclusive and equally probable strains of disease, each likely to afflict 10% of the population. A vaccine gives complete protection against one strain and no protection against the other.

Would you volunteer to receive the vaccine? (Circle one number)

1	2	3	4	5	6	7
Almost certainly would <u>not</u> get vaccinated						Almost certainly would get vaccinated

In the drawing below, there are ten stations along a route between Start and Finish. Consider a bus that travels, stopping at exactly 7 stations along this route.



What is the number of different patterns of 7 stops that the bus can make?

Please indicate how confident you are in your answer. (Circle one)

Very Sure	Quite Sure	Moderately Sure	Slightly Sure	Not Sure At All

Choose between:

A. a sure loss of $750

B. 85% chance to lose $1,000 and
15% chance to lose nothing

APPENDIX B

DIRECTIONS FOR:

ADDITION TASK

In this task you are asked to ADD three numbers together.

Please write your answers in the boxes below the problems. Several practice problems are given below with the first one correctly worked. Work the problems in order going across the page.

Practice Problems:

4	7	12	84
9	6	5	54
1	15	67	72
14			

Remember, this is a test of your speed in adding numbers.

PLEASE WORK AS FAST AS YOU CAN WITHOUT SACRIFICING ACCURACY!

24	75	6	43	64	67	68	51	41	34
74	18	26	23	29	89	95	42	3	59
8	19	89	18	22	32	52	13	59	16

59	74	44	31	19	85	39	34	13	7
86	78	71	98	63	47	25	51	42	67
55	45	11	59	92	85	77	65	53	38

36	77	66	18	84	39	17	14	48	79
21	41	58	38	14	91	18	88	74	34
54	53	34	67	19	82	39	59	31	65

64	52	49	32	86	21	4	71	77	13
99	46	28	8	34	56	51	40	34	23
5	91	36	53	19	45	8	44	22	48

76	93	21	19	46	64	64	24	49	10
86	13	57	55	7	38	15	83	2	3
93	87	83	58	80	49	26	19	39	7

21	6	27	16	8	93	76	13	77	71
8	98	47	41	37	13	86	23	34	40
27	31	17	38	98	87	93	48	22	44

49	6	62	4	10	21	45	80	69	64
4	1	25	49	40	58	73	36	93	91
37	5	45	6	55	47	9	63	50	34

25	75	85	31	65	19	21	89	50	8
76	80	12	49	97	40	55	15	19	35
6	47	21	63	7	65	85	89	41	96

6	77	38	20	38	3	18	47	46	97
96	36	18	65	1	24	20	29	5	90
33	24	56	94	58	91	37	34	78	79

23	9	78	83	35	40	15	33	60	52
49	25	43	45	57	25	89	10	40	32
19	46	55	83	18	16	60	51	51	80

16	72	63	36	60	65	49	86	64	24
39	88	56	23	84	31	76	36	13	65
40	91	32	75	53	24	33	17	28	17

7	89	35	75	7	35	39	15	16	60
39	15	49	76	28	61	27	40	13	36
96	85	63	47	91	18	79	65	28	47

78	39	44	50	38	30	42	5	86	60
11	24	88	21	85	68	10	39	12	84
48	77	9	91	6	96	55	80	82	77

9	32	57	24	62	26	15	63	10	59
79	57	19	73	34	30	78	47	45	26
85	98	60	63	78	91	97	68	89	14

78	82	38	51	18	88	69	14	83	61
58	98	16	50	61	33	8	62	28	53
42	18	44	18	59	37	24	50	10	74

38	99	12	32	63	49	73	68	51	84
33	88	75	39	82	2	99	79	35	10
63	40	69	49	24	99	63	46	43	14

47	13	91	27	84	45	54	56	45	5
28	64	33	72	33	36	30	52	52	22
76	82	62	43	7	98	12	34	35	43

44	40	96	20	55	79	50	36	71	78
36	56	7	63	51	26	47	35	95	38
78	86	39	24	79	46	97	53	87	73

DIRECTIONS FOR:

NUMBER COMPARISON TASK

In this task you are asked to compare two numbers and decide whether or not they are the same. If the numbers are the same, go on to the next pair, making no mark between the numbers. If the numbers are not the same, put an X on the line between them. Several examples are given below with the first few marked correctly. Practice on the remaining five.

659	_____	659
73845	X	73855
1624	_____	1624
438	X	436
4821459	_____	4814259
658331	_____	656331
11653	_____	11652
617439428	_____	617439428
1860439	_____	1860439

Remember, this is a test of your speed in comparing two numbers.

PLEASE WORK AS FAST AS YOU CAN WITHOUT SACRIFICING ACCURACY!

Make an X on the line between the numbers that are not the same.

7573	_____	7573	289414	_____	289414
347820	_____	349820	17906	_____	17906
4951	_____	4951	16719581024	_____	16719581024
4573043	_____	4571043	16719581024	_____	16719581024
37501243	_____	37501243	3965701746	_____	3665701746
125093562816	_____	125093562816	135299235127	_____	135299235127
8350107234	_____	8350107234	13897143	_____	13897145
34861890172	_____	3486170172	84215073508	_____	84216073508
506915	_____	596915	941856031195	_____	941856431195
786071254329	_____	786071255329	8041638	_____	8041438
41345073	_____	41345073	70317494	_____	70317494
925660752	_____	925660752	35789462806	_____	35789562806
16719581023	_____	16717581023	6312850395	_____	6312850795
3965701745	_____	3965701745	731497130632	_____	731497130632
135299235126	_____	135299235136	591137508	_____	591167508
13897142	_____	13897142	21553401284	_____	21553401284
84215073506	_____	84215073507	1251373807	_____	1251373307
941856031194	_____	941846031194	903148671504	_____	903148671504
8041637	_____	8071637	68794353108	_____	68754354108
70317493	_____	70317493	37501235	_____	37501235
35789462805	_____	35789462805	125093562817	_____	125093562817
6312850394	_____	6312850394	8350107235	_____	8350107235
731497130631	_____	731497130681	34861890173	_____	34861840173
591137507	_____	591127507	506916	_____	506616

Make an X on the line between the numbers that are not the same.

639 _____ 639

4714306 _____ 4715306

65382 _____ 65372

710 _____ 710

43210573 _____ 43210573

6182653905221 _____ 6182653905221

43270105338 _____ 43276105338

27109816843 _____ 27109816853

519605 _____ 519605

923452170687 _____ 923452170687

370543141 _____ 310543141

2570665292 _____ 2570665292

32018591670 _____ 32018691670

5471075693 _____ 5471075683

621532992531 _____ 621582992531

24179830 _____ 24179830

70537051248 _____ 7053705248

7361408 _____ 7361708

39471307 _____ 39471507

508264987503 _____ 508264987503

4930582136 _____ 4930582136

136031794137 _____ 136031794137

705731195 _____ 705736195

38210435512 _____ 38210535512

414982 _____ 415982

60971 _____ 60971

16253948 _____ 1653948

42018591760 _____ 43018591760

647107569 _____ 647107569

721532992531 _____ 721582992531

341798301 _____ 341798701

80537051248 _____ 80537051248

5911306581491 _____ 5911306581491

83614081 _____ 83614081

49471307 _____ 47471307

6082649875 _____ 6082647875

5930582136 _____ 5730582136

236031794137 _____ 236031294137

805731195 _____ 805131195

48210435512 _____ 48210435612

405176841309 _____ 405176841309

80145349786 _____ 80145349796

53210573 _____ 53210573

718265390521 _____ 718265390521

5327010538 _____ 5327010538

37109816843 _____ 37189816843

619605 _____ 619505

123452170687 _____ 123452190687

Make an X on the line between the numbers that are not the same.

587	_____	578	587692	_____	587862
5714307	_____	5741307	17906	_____	17806
78492	_____	78429	84935261	_____	84935261
912	_____	911	96719581024	_____	96719581034
513210573	_____	513210573	865701746	_____	865707146
7282743916332	_____	7282743916332	135299235127	_____	735299235127
54381916449	_____	54381961449	103897143	_____	107897143
88109726854	_____	88109725854	84215073508	_____	84215073508
621705	_____	621795	1941856031195	_____	1941865031195
834573281897	_____	834573281897	18041638	_____	18041638
471544232	_____	471544432	70317494	_____	70317494
2881795292	_____	2881795292	5789462806	_____	5787462806
43197682680	_____	43197683680	6312850395	_____	6312850395
7471276692	_____	7472176692	731497130632	_____	731492130632
732533882731	_____	732533882731	591137508	_____	591137508
25279840	_____	25279740	21553401284	_____	21653401284
70842165249	_____	70842156249	903148671504	_____	903148671504
7372812	_____	7372812	68794354108	_____	69794354108
38765432	_____	38764532	37501235	_____	37502135
908264986513	_____	908264986513	125093562817	_____	125093562817
5821623387	_____	5821623387	8350107235	_____	8350107235
137142795238	_____	137143795238	34861890173	_____	34861898173
707732298	_____	707733298	506916	_____	506916
47120476613	_____	47120476513	786071254321	_____	786091254321

Make an X on the line between the numbers that are not the same.

70415725	_____	70415725	305487	_____	305487
109269	_____	109279	28682	_____	28628
8051647	_____	8051647	2782849055	_____	2782849055
942865031194	_____	942856031194	67194701421	_____	67197401421
4952	_____	4953	6481194625	_____	6481194625
507817	_____	507817	799317134	_____	799317134
5958721	_____	5958721	96913689142	_____	96913789142
3264	_____	3264	31195499132	_____	31195599132
807927595	_____	807297595	6008410	_____	6008510
55678451895	_____	55687451895	44993107	_____	44983107
1944239	_____	1944229	30177077301	_____	30177077301
80955	_____	80955	69559800	_____	69558900
266743	_____	266473	806357895628	_____	806359875628
2098094095	_____	2087094095	7170326193	_____	7170326193
665791477	_____	665791477	805591167	_____	805591167
2782069235	_____	2782068235	51243521048	_____	51243512048
138475	_____	134875	513712807	_____	513712907
6548977352	_____	6548977352	405176843103	_____	405176743103
8041	_____	8041	10868754355	_____	10868764355
4937031	_____	4937001	2579872	_____	2579872
6692587	_____	6692587	892587540001	_____	892587640001
90314867604	_____	90314687604	12432444172	_____	12432444272
892427984	_____	892427984	34485868719	_____	34485858719
8408006	_____	8408906	571113	_____	571113

Make an X on the line between the numbers that are not the same.

21043 _____ 21044

345123 _____ 345125

801453 _____ 802453

6814 _____ 6841

104355124 _____ 103455124

5471007 _____ 5471070

14131054 _____ 14311054

4321 _____ 4312

82653 _____ 82653

3657305 _____ 3657305

94173 _____ 94137

195195 _____ 195185

551280 _____ 551280

706871 _____ 706781

9816 _____ 9817

0660187108 _____ 0660178108

7057 _____ 7067

507508 _____ 507508

317653 _____ 317643

6972157 _____ 6972157

113016 _____ 113017

4747241 _____ 4746241

289534 _____ 289534

5911302765 _____ 5911302765

489721 _____ 489271

161162 _____ 161162

865751 _____ 865715

5734 _____ 5733

5086091137 _____ 5086091137

62542827581 _____ 62542826581

371872691452 _____ 371872691452

713044 _____ 731044

2109509 _____ 2109509

2427 _____ 2424

218 _____ 218

56980321 _____ 56980321

1008943825 _____ 1008943825

57331788 _____ 57331789

90842615879 _____ 90842614879

59169030 _____ 59159030

700521 _____ 700421

100075 _____ 100075

21724 _____ 21742

106508794371 _____ 106508794371

7341920316 _____ 7341921316

961508 _____ 961608

2724597 _____ 2724697

489521 _____ 489251

APPENDIX C

REACTIONS TO EXPERIMENTAL CONDITIONS

Please circle the number that most closely fits your reaction.

The noise I heard in the room while working on the tasks was:

1	2	3	4	5	6	7
extremely relaxing						extremely irritating

The noise I heard in the room while working on the tasks was:

1	2	3	4	5	6	7
extremely pleasant						extremely unpleasant

To what extent was the noise you heard distracting:

1	2	3	4	5	6	7
the noise made it extremely easy to concentrate						the noise made it extremely difficult to concentrate

How easy were the tasks:

1	2	3	4	5	6	7
extremely difficult						extremely easy

APPENDIX D

Code # _____

Age _____

Sex _____

ADJECTIVE CHECK LIST

DIRECTIONS: On the other side of this page you will find words which describe different kinds of moods and feelings. Mark an X in the boxes beside the words which describe how you feel right now at this point in the session. Some of the words may sound alike, but we want you to check <u>all</u> the words that describe your present feelings. Work rapidly.

1 ☐ active
2 ☐ adventurous
3 ☐ affectionate
4 ☐ afraid
5 ☐ agitated
6 ☐ agreeable
7 ☐ aggressive
8 ☐ alive
9 ☐ alone
10 ☐ amiable
11 ☐ amused
12 ☐ angry
13 ☐ annoyed
14 ☐ awful
15 ☐ bashful
16 ☐ bitter
17 ☐ blue
18 ☐ bored
19 ☐ calm
20 ☐ cautious
21 ☐ cheerful
22 ☐ clean
23 ☐ complaining
24 ☐ contented
25 ☐ contrary
26 ☐ cool
27 ☐ cooperative
28 ☐ critical
29 ☐ cross
30 ☐ cruel
31 ☐ daring
32 ☐ desperate
33 ☐ destroyed
34 ☐ devoted
35 ☐ disagreeable
36 ☐ discontented
37 ☐ discouraged
38 ☐ disgusted
39 ☐ displeased
40 ☐ energetic
41 ☐ enraged
42 ☐ enthusiastic
43 ☐ fearful
44 ☐ fine
45 ☐ fit
46 ☐ forlorn
47 ☐ frank
48 ☐ free
49 ☐ friendly
50 ☐ frightened
51 ☐ furious
52 ☐ gay
53 ☐ gentle
54 ☐ glad
55 ☐ gloomy
56 ☐ good
57 ☐ good-natured
58 ☐ grim
59 ☐ happy
60 ☐ healthy
61 ☐ hopeless
62 ☐ hostile
63 ☐ impatient
64 ☐ incensed
65 ☐ indignant
66 ☐ inspired
67 ☐ interested
68 ☐ irritated
69 ☐ jealous
70 ☐ joyful
71 ☐ kindly
72 ☐ lonely
73 ☐ lost
74 ☐ loving
75 ☐ low
76 ☐ lucky
77 ☐ mad
78 ☐ mean
79 ☐ meek
80 ☐ merry
81 ☐ mild
82 ☐ miserable
83 ☐ nervous
84 ☐ obliging
85 ☐ offended
86 ☐ outraged
87 ☐ panicky
88 ☐ patient
89 ☐ peaceful
90 ☐ pleased
91 ☐ pleasant
92 ☐ polite
93 ☐ powerful
94 ☐ quiet
95 ☐ reckless
96 ☐ rejected
97 ☐ rough
98 ☐ sad
99 ☐ safe
100 ☐ satisfied
101 ☐ secure
102 ☐ shaky
103 ☐ shy
104 ☐ soothed
105 ☐ steady
106 ☐ stubborn
107 ☐ stormy
108 ☐ strong
109 ☐ suffering
110 ☐ sullen
111 ☐ sunk
112 ☐ sympathetic
113 ☐ tame
114 ☐ tender
115 ☐ tense
116 ☐ terrible
117 ☐ terrified
118 ☐ thoughtful
119 ☐ timid
120 ☐ tormented
121 ☐ understanding
122 ☐ unhappy
123 ☐ unsociable
124 ☐ upset
125 ☐ vexed
126 ☐ warm
127 ☐ whole
128 ☐ wild
129 ☐ willful
130 ☐ wilted
131 ☐ worrying
132 ☐ young

APPENDIX E

The following is a list of possible ways of dealing with a situation. Consider the task you just completed and the conditions under which you worked. For each item in the attached questionnaire, decide if you behaved in the way described. Mark "Yes" for each of the following that you think applied to you.

Mark a "Yes" for each of the following that applied.

___ 1. I just concentrated on what I had to do next--the next step.

___ 2. I went over the problem again and again in my mind to try to understand it.

___ 3. I turned to work or substitute activity to take my mind off things.

___ 4. I felt that time made a difference--the only thing to do was to wait.

___ 5. I bargained or compromised to get something positive out of the situation.

___ 6. I did things which I didn't think would work, just to be doing something.

___ 7. I tried to make those responsible for this situation see my point.

___ 8. I talked to other people to find out more about the situation.

___ 9. I blamed myself.

___ 10. I concentrated on something good that could come out of this.

___ 11. I criticized or lectured myself.

___ 12. I tried not to burn bridges behind me, but left things open somewhat.

___ 13. I hoped a miracle would happen.

___ 14. I just went along with fate; sometimes you just have bad luck.

___ 15. I went on as if nothing had happened.

___ 16. I felt bad that I couldn't avoid the problem.

___ 17. I kept my feelings to myself.

___ 18. I looked for the "silver lining", so to speak; tried to look on the bright side of things.

___ 19. I slept more than usual.

___ 20. I got mad at the people or things that caused the problem.

___ 21. I accepted sympathy and understanding from people.

___ 22. I told myself things that helped me feel better.

___ 23. I have been inspired to do something creative.

___ 24. I tried to forget the whole thing.

___ 25. I am getting professional help and usually do what they recommend.

___ 26. I changed or grew as a person in a good way.

___ 27. I waited to see what would happen.

___ 28. I did things that were totally new, that I never would have done if this hadn't happened.

___ 29. I tried to make up to someone for the bad thing that happened.

___ 30. I made plans of action and followed them.

___ 31. I accepted the next best thing to what I wanted.

___ 32. I left my feelings out somehow.

___ 33. I realized that I brought the problems on myself.

___ 34. I will come out of the experience better than when I went in.

___ 35. I talked to someone who could do something concrete about the problem.

___ 36. I got away from it for a while; tried to rest or took a vacation.

___ 37. I tried to make myself feel better by eating, drinking, smoking, taking medication, etc.

___ 38. I took big chances or did things that were very risky.

___ 39. I found new faith or some important truth about life.

___ 40. I tried not to act too hastily or follow a first hunch.

___ 41. I joked about it.

___ 42. I maintained my pride and kept a stiff upper lip.

___ 43. I rediscovered what is important in life.

___ 44. I tried to change something so things would turn out all right.

___ 45. I avoided being with people in general.

___ 46. I didn't let it get to me, refused to think too much about it.

___ 47. I asked people I respect for advice and followed it.

___ 48. I kept others from knowing how bad things were.

___ 49. I made light out of the situation, refused to get too serious about it.

___ 50. I talked to people about how I was feeling.

___ 51. I stood my ground and fought for what I wanted.

___ 52. I took it out on other people.

___ 53. I drew on past experiences; I was in a similar situation before.

___ 54. I just took things one step at a time.

___ 55. I knew what had to be done, so I doubled my efforts and tried harder to make things work.

___ 56. I refused to believe what was happening.

___ 57. I made promises to myself that things would be different next time.

___ 58. I came up with a couple different solutions to the problem.

___ 59. I accepted the situation, since nothing could be done.

___ 60. I wished I was a stronger person--more optimistic and forceful.

___ 61. I accepted my strong feelings, but didn't let them interfere with other things too much.

___ 62. I wished that I could change what had happened.

___ 63. I wished that I could change the way I feel.

___ 64. I changed something about myself so that I could deal with the situation better.

___ 65. I daydreamed or imagined a better time or place.

___ 66. I had fantasies or wishes about how things might turn out.

___ 67. I thought about fantastic or unreal things (like the perfect revenge or finding a million dollars) that made me feel better.

___ 68. I wished that the situation would have gone away or somehow would be over with.

___ 69. I did something different from any of the above.

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